

✠ PART 10.

PRICE 1s. ✠

**RESEARCHES**

ON

**FOSSIL BONES,**

IN WHICH ARE ESTABLISHED

THE CHARACTERS OF

**VARIOUS ANIMALS**

**WHOSE SPECIES HAVE BEEN DESTROYED**

**BY THE REVOLUTIONS OF**

**The Globe ;**

BY

**BARON CUVIER,**

Great Officer of the Legion of Honour, Counsellor of State, and Member of the Royal Council of Public Instruction, One of the Forty of the French Academy, Perpetual Secretary to the Academy of Sciences, Member of the Academies and Royal Societies of London, Berlin, Petersburg, Stockholm, Edinburgh, Copenhagen, Göttingen, Turin, Bavaria, Modena, The Netherlands, Calcutta, and of the Linnæan Society of London, &c. &c. &c. &c.

**FOURTH EDITION,**

**Revised and Completed**

**BY ADDITIONAL NOTES,**

**AND A**

**SUPPLEMENT LEFT BY THE AUTHOR.**

Triomphante des eaux, du trépas, et du temps,  
La terre a cru revoir ses premiers habitants.

DEUILLE.

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**IN FOUR VOLUMES.**

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**LONDON:**

**G. HENDERSON, 2, OLD BAILEY, LUDGATE-HILL.**

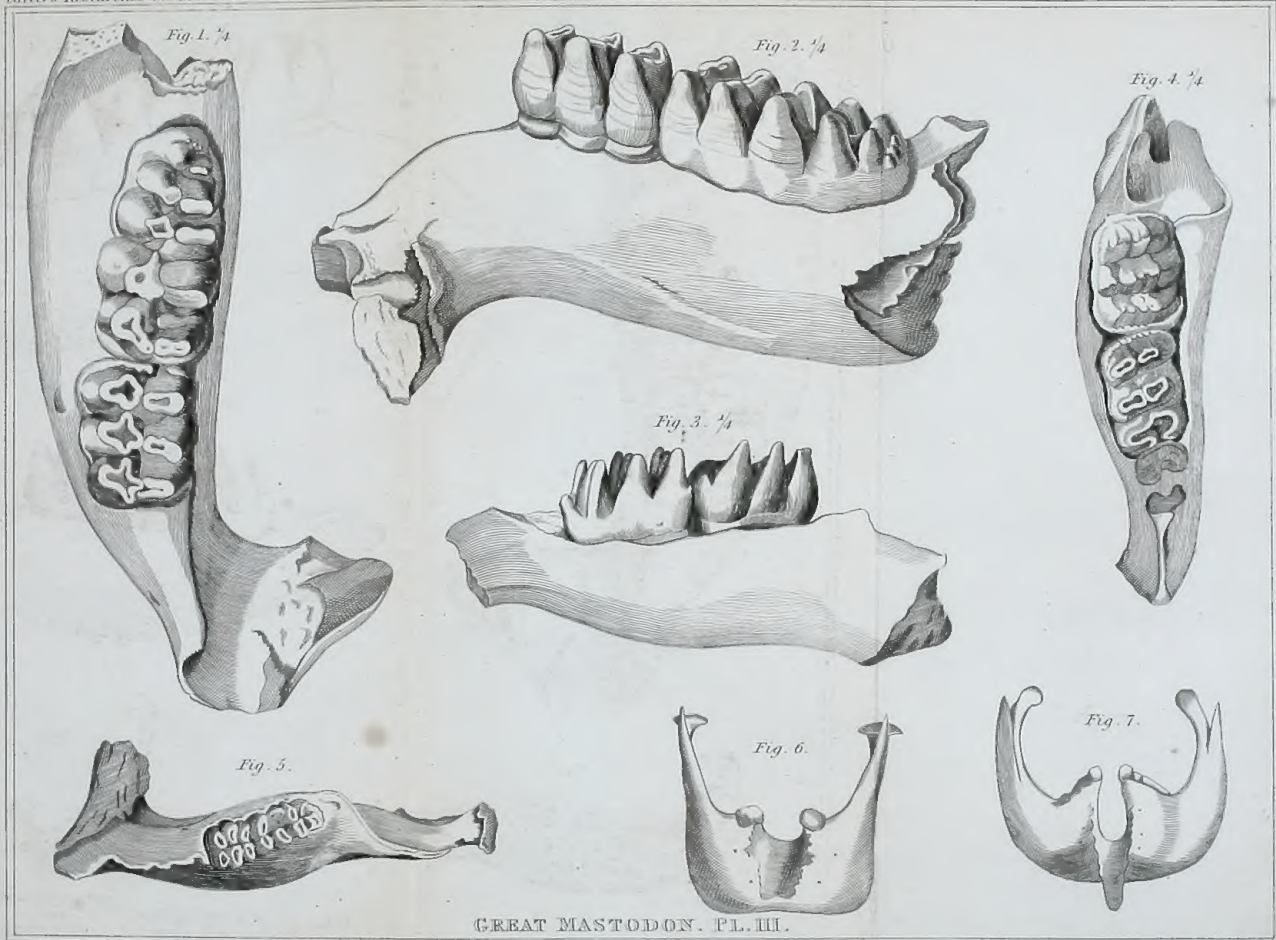
**AND SOLD BY ALL BOOKSELLERS.**

**1835.**









GREAT MASTODON. PL. III.



Fig. 4.  $\frac{1}{4}$

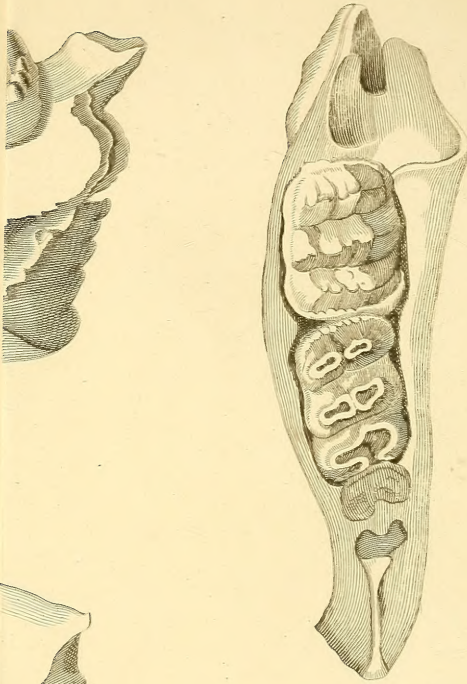
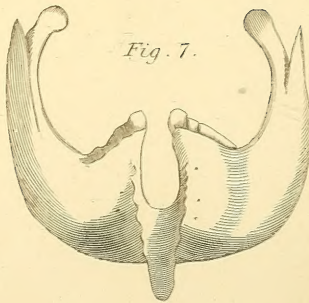
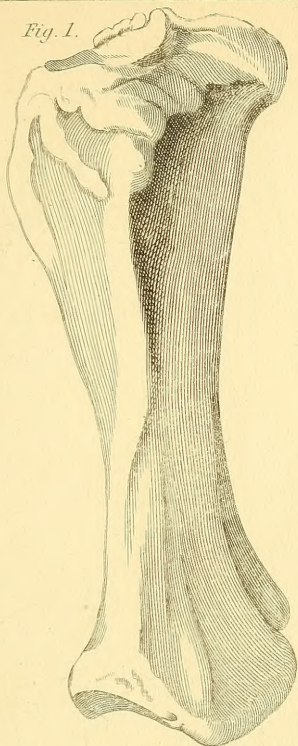


Fig. 7.

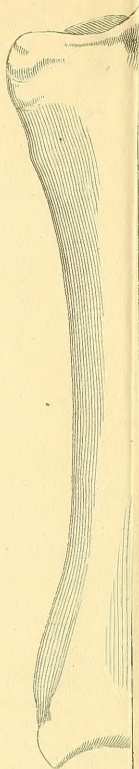




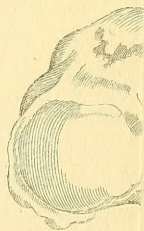
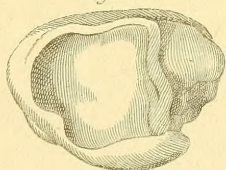
*Fig. 1.*



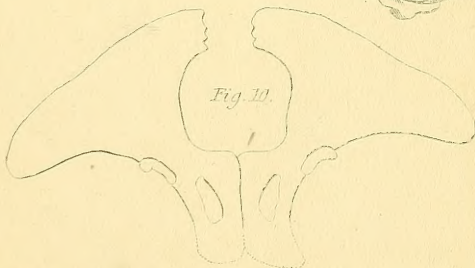
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*Fig. 3.*



*Fig. 10.*







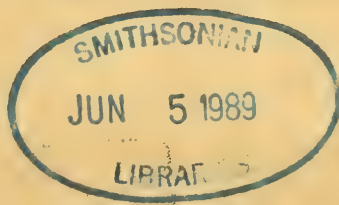




|  |       |
|--|-------|
| Small diameter of the humeral facette .....                  | 0,054 |
| Great diameter of the carpal surface .....                   | 0,078 |
| Small ditto .....  | 0,052 |
| Diameter of the middle of the bone .....                     | 0,050 |
| Antero-posterior diameter of the scaphoid of the carpus .... | 0,070 |
| Breadth .....  | 0,028 |
| Height .....   | 0,036 |
| Antero-posterior length of the semi-lunar bone .....         | 0,067 |
| Height in front .....  | 0,059 |
| Breadth in front and below .....                             | 0,037 |
| Antero-posterior length of the os cuneiforme .....           | 0,045 |
| Height in front .....  | 0,044 |
| Length of the os pisiforme .....                             | 0,067 |
| Thickness in the centre .....                                | 0,028 |
| Antero-posterior length of the trapezoid .....               | 0,040 |
| Breadth .....  | 0,029 |
| Height .....   | 0,021 |
| Antero-posterior length of the os magnum .....               | 0,080 |
| Breadth in front .....                                       | 0,044 |
| Greatest height .....  | 0,033 |
| Antero-posterior length of the os cuneiforme .....           | 0,082 |
| Breadth in front .....                                       | 0,068 |
| Greatest height .....  | 0,040 |
| Length of the bone of the great toe .....                    | 0,051 |
| Thickness .....  | 0,028 |
| Length of the middle bones of the metacarpus .....           | 0,147 |
| Breadth in the centre .....                                  | 0,040 |
| Length of the metacarpal bone of the index .....             | 0,118 |
| Length of the metacarpal bone of the little toe .....        | 0,104 |
| Length of the first phalanges .....                          | 0,055 |
| Length of the second .....                                   | 0,034 |
| Length of the third .....                                    | 0,024 |

## POSTERIOR EXTREMITY.

|  |       |
|--|-------|
| Breadth from the anterior crest of one of the ossa ilium,<br>between the two spines .....                                  | 0,397 |
| Distance between the exterior spine and the anterior edge of<br>the cotyloid cavity .....                                  | 0,370 |
| Breadth of the narrowest part of the neck .....  | 0,087 |
| Diameter of the cotyloid cavity .....  | 0,079 |
| Distance between the posterior edge of the cotyloid cavity<br>and the upper extremity of the tuberosity of the ischium ..  | 0,253 |
| Distance between the inferior edge of the cotyloid cavity<br>and the anterior extremity of the symphysis .....             | 0,142 |
| Length of the symphysis .....  | 0,250 |
| Length of the ovalar hole .....  | 0,154 |
| Breadth .....  | 0,086 |
| Distance between the posterior extremity of the symphysis<br>and the inferior extremity of the tuberosity of the ischium . | 0,190 |
| Distance between the external spines of the ossa ilium .....   | 0,770 |





|   |       |
|---|-------|
| Distance between the superior and inferior extremities of the tuberosity of the ischium . . . . .                           | 0,182 |
| Distance between the two upper extremities of the ischiatic tuberosities . . . . .  | 0,258 |
| Greatest breadth of the os sacrum at its anterior facette . . . .   | 0,261 |
| Length of the femur, from the summit of its upper head to the base of the internal condyle . . . . .                        | 0,505 |
| Greatest upper breadth from the most prominent part of the head to that of the great trochanter . . . . .                   | 0,180 |
| Diameter of the head . . . . .  | 0,073 |
| Greatest inferior breadth between the two condyles . . . . .  | 0,155 |
| Distance between the posterior edge of the internal condyle and the anterior internal angle of the articular pulley . . . . | 0,185 |
| Distance between the posterior edge of the external condyle and the anterior external angle of the pulley . . . . .         | 0,142 |
| Average length of the articular pulley next to the rotula . . . .   | 0,084 |
| Breadth . . . . .   | 0,078 |
| Transverse diameter at the smallest part of the bone . . . . .  | 0,063 |
| Height of the rotula . . . . .  | 0,075 |
| Breadth . . . . .   | 0,100 |
| Thickness . . . . .   | 0,060 |
| Length of the tibia, from the centre of its upper head to the centre of its lower head . . . . .                            | 0,346 |
| Transverse diameter of the upper head . . . . .   | 0,152 |
| Antero-posterior diameter between its two articular facettes . .  | 0,112 |
| Transverse diameter of the lower head . . . . .   | 0,089 |
| Average antero-posterior diameter . . . . .   | 0,058 |
| Projection of the internal malleolus, near the base . . . . .   | 0,032 |
| Transverse diameter of the smallest part of the bone . . . . .  | 0,057 |
| Length of the fibula . . . . .  | 0,287 |
| Length of the calcaneum . . . . .   | 0,175 |
| Length of its posterior projection . . . . .  | 0,117 |
| Height of its greatest astragalian facette . . . . .  | 0,040 |
| Breadth . . . . .   | 0,056 |
| Length of its smallest astragalian facette . . . . .  | 0,031 |
| Breadth . . . . .   | 0,025 |
| Length of its cuboidian facette . . . . .   | 0,052 |
| Breadth . . . . .   | 0,027 |
| Length of the astragalus at the centre . . . . .  | 0,077 |
| Breadth below . . . . .   | 0,072 |
| Height . . . . .  | 0,056 |
| Breadth of the cuboidian portion of its inferior pulley . . . . .   | 0,037 |
| Breadth of the schaphoidian . . . . .   | 0,042 |
| Breadth of the cuboid in front . . . . .  | 0,045 |
| Length . . . . .  | 0,066 |
| Greatest thickness in front . . . . .   | 0,037 |
| Breadth of the schaphoid . . . . .  | 0,050 |
| Length . . . . .  | 0,065 |
| Thickness . . . . .   | 0,025 |
| Length of the two large bones of the metatarsus . . . . .   | 0,132 |
| Breadth at the centre . . . . .   | 0,037 |

|   |       |
|---|-------|
| Length of the two smaller bones .....                 | 0,096 |
| Breadth at the centre .....                           | 0,030 |
| Length of the two first phalanges of the centre ..... | 0,060 |
| Length of the two laterals .....                      | 0,053 |
| Length of the second phalanges of the centre .....    | 0,033 |
| Length of the second laterals .....                   | 0,026 |
| Length of the last or unguinals .....                 | 0,026 |

## SECTION II.

## ON THE FOSSIL REMAINS OF THE HIPPOPOTAMUS.

There is but one species of living hippopotamus known at the present day, as we have just seen in the preceding article: but I have discovered two, and it may be four, of the fossil species. The first is so much similar to the living species that I have not been able to distinguish them: the second is about the figure of a wild boar, but in every other particular, as we shall soon have occasion to see, it must be pronounced a copy in miniature of the great species. The third may be said to be intermediate between the two others. Lastly, I find traces of a fourth, almost as large as a Siamese pig.

Our acquaintance with the smaller species is entirely owing to my researches; and as for the larger, although its existence in the fossil state might have been previously announced, it was not until the publication of my first edition, that it was proved beyond a doubt.

In fact, the late M. Faujas de Saint Fond, an author whose works upon this subject immediately preceded mine, states most distinctly, in his Essay on Geology (vol. 1, page 364), that he had seen nothing in the Museums he had visited in his travels, or in the authors he had consulted, from whence he might conclude that the hippopotamus had been found in the fossil state along with the elephant, the rhinoceros, and the other great quadrupeds of the warm climates.

I have myself examined these same authors, and most certainly I have not found in them the positive testimony required; but at least I have had an opportunity of observing, that the most learned men have frequently committed grave mistakes, by attempting to apply the name hippopotamus to many fossils to which it was wholly inapplicable.

Thus I have already had occasion to remark, that all that is said by Daubenton of the supposed fossil grinders of an hippopotamus, in his Description of the King's Museum (Natural History, vol. xii, in 4to), is in reality to be referred to the intermediate grinders of the great mastodon of Ohio, or mammoth of the English and Americans: and what he further states in the same place, concerning petrified teeth bearing a relation to those of the hippopotamus, is referable to the teeth of another species, confounded by former naturalists with the species of Ohio, and which I have distinguished by the title of *narrow-toothed mastodon*.

But the same observation will not apply to the numbers MCII and MCIV, of the same passage. The first is a portion of a jaw, containing two grinders, the other is a solitary grinder. These are actually belonging to an hippopotamus, as I shall shew further on. They are,

moreover, real fossils, and bear all the marks of a long stay in the interior of the earth. Their consistence is altered; their grain is tinged by ferruginous substances: the enamel of the first of these pieces is of a black colour, as is very often the case in fossil teeth; we may observe upon them some remains of the earthy bed in which they were found; in a word, all that is wanting is some evidence of their origin—a defect which I shall endeavour to supply by some probable conjectures.

Peter Camper has also spoken of the fossil teeth of the hippopotamus, but he seems to have fallen into the same mistake as Daubenton. Here is his article on the subject: it is taken from the *Memoirs of the Academy of Petersburg*. (*Nova Acta*, ii, 1788, page 258).

“In the British Museum (he writes to M. Pallas), I took a drawing of the molar tooth of a gigantic hippopotamus, which is four times larger than that immense molar tooth, a figure of which I published, and which you described. (Tab. viii, Act. Acad. Petrop. i, Part ii, page 214.)”

Nor did Camper understand by this a tooth of the animal of Ohio, for he speaks at great length of this same animal in the next page; and besides, we have positive proof that he was well acquainted with it, as he had distinguished it from the hippopotamus in express terms, so early as 1777, in the second part of his *Acta*, page 219.

As I have been unable to procure any positive intelligence concerning this gigantic tooth, I am obliged to have recourse to conjecture. The teeth of the narrow-toothed mastodon, as I observed in the chapter that treats of them, present, at a certain period of their detrition, trefoil figures resembling those of the hippopotamus; and as Camper had as yet no idea of the differences which distinguish this animal from that of Ohio, he might have been deceived in the matter of a solitary tooth. However this may be, certain it is that the tooth here spoken of cannot by any possibility be referred to our common hippopotamus, nor to the ordinary fossil hippopotamus, as it exceeds them four times in size.

Merk would seem to have embraced the erroneous impression of Camper. In the note, at page 21 of his first letter, we find these words: “I have in my possession a molar tooth, found in the environs of Frankfort on the Maine, exactly similar to one of an hippopotamus which is engraved in the first volume of the *Epochs of Nature*, by M. Buffon, plate 3.” Now this plate 3 represents an intermediate tooth of a mastodon of Ohio, the summits of which are somewhat worn.

M. Deluc, in his fourth letter on Geology, page 414, speaks of the tooth of an hippopotamus found among some volcanic productions in the environs of Frankfort: but Merk tells us in his third letter, page 20 (note), that it belonged to a rhinoceros.

We find more positive testimony upon this subject recorded at a more early period. It is a passage from Antoine de Jussieu, in the *Memoirs of the Academy of Sciences* for 1724. After describing in detail, and giving a drawing of the head of a real hippopotamus, he goes on to say: “The sight of this head and these feet enabled me to recognise, at first sight, similar petrified bones, found among a number



of figured stones, at a place called *Mosson*, in the territory of Montpellier.

"These discoveries, at which M. Chirac was present, embarrassed us so much the more, as, being unable to find any resemblance between them and the skull of the horse and the ox, with which we compared them, we were at a loss to know to what animal to attribute them; and it was not until we had obtained a sight of the remains of the latter, that we became convinced that these petrified bones had belonged to the hippopotamus."

Although Antoine de Jussieu has not given either a drawing or a particular description of these fossils, the manner and the place in which he describes them, after having just described a real head, and having, as it would appear, the fresh bones and the fossils beneath his eyes, leave no room for doubting of the latter having really resembled those of the animal to which he attributes them; nay, I have sufficient reason for believing that the specimens observed by Chirac, and by Antoine de Jussieu, are precisely the same pointed out by Daubenton in numbers MCII and MCIV, which I shall describe farther on. It is probable that Chirac, who was then Superintendent of the King's Museum, had transferred them from Montpellier to Paris, and placed them in the Museum, where Daubenton may afterwards have found them, without any further reference.

The teeth which Charles Nicolas Lang had put forth some years previously, for those of the hippopotamus, in his "*Historia lapidum figuratorum Helvetiæ*," printed in 1708, plate 11, figs. 1 and 2, are not to be classed with the preceding: they are nothing more than horses' teeth. Fig. 1 is a germ which has not as yet emerged from the gum, and fig. 2 an old worn-down tooth. Lithologists have frequently been deceived in the teeth of the horse, although they belong to so common an animal. We shall see this more in detail in another chapter.

I likewise find a piece attributed to the hippopotamus in the writings of an author almost of our own times, with as little appearance of truth as marked the statements of Lang. It is the same cited in the catalogue of the Museum of Berlin, by Davila, vol. iii, page 221, article 296. He expresses himself thus:—

"The jaw of an hippopotamus, petrified and embedded in its matrix of plaster stone found in the neighbourhood of Paris. The lower jaw still preserves five or six molar teeth, with their roots partly engaged in their sockets, and partly emerging from them. The upper jaw is almost entirely destroyed, and offers nothing more than the impression of the other molar teeth opposite to those of the lower jaw. The latter preserve their greenish enamel, and are in other respects similar to the teeth of the hippopotamus, which have been represented by M. de Jussieu in the Memoirs of the Academy of Sciences. This jaw is a little more than six inches in length and four in breadth."

I have quite sufficient knowledge of the fossils contained in our plaster quarries, to take upon me to say that nothing belonging to the hippopotamus was ever found in them: besides, five teeth of an hippopotamus must assuredly have occupied a space measuring at the very least eight inches in length.

Hence I feel firmly persuaded that Davila, or rather his fellow labourer, Romé de l'Isle, must have bestowed his attention on some fragment of my great *palæotherium*; his having fancied that these teeth resembled those of Jussieu may be accounted for by the fact of the deficiency of the drawings of the latter in size and accuracy.

I presume the same to be the case with the bones of the hippopotamus, which Lamétherie tells us were found at Mary near Meaux (Theory of the Earth, v, p. 198), but the description of which he does not give. The environs of Meaux are in a great measure gypseous, and I know that the fossils yielded by them are similar to those of the neighbourhood of Paris.

Faujas himself had long before spoken of the teeth of the hippopotamus. He thus expresses himself in a letter to Lamétherie on the bones found by M. de Fay, near Orleans, inserted in the Physical Journal of December, 1794, p. 445.

"Here are some of the details of the most marked characteristics which I observed in the remains of the bones found in the quarries of Montabusard.

"1st. The petrified tooth of an hippopotamus, weighing 8 ounces, 6 penny-weights, and 15 grains, although it is not entire, for there is a portion of it wanting at the extremity of the crown, &c. On comparing this tooth with those of the largest heads of the hippopotamus in the Museum of Natural History, I have not found one approaching this in size; so that the animal to which this tooth belonged must have been at least three times larger than the stuffed hippopotamus in the gallery of the Museum, which came from the Museum of the Hague."

I have examined this tooth, and I am positive, as I have already stated, that it belonged to a mastodon.

But if it has happened that authors have sometimes passed off for bones and teeth of the hippopotamus some pieces which did not belong to that animal, it has also been the case that some authors have had them without being aware of the circumstance, and have attributed them to animals to which they did not belong. Among these we may reckon Aldrovandus. In his work, *De Metallicis*, book 4, page 828, he represents, plate 4, fig. 1, the real fossil molar of an hippopotamus, the fourth or fifth upper half worn; and in fig. 2 a posterior lower tooth, very slightly worn; plate 7 is, moreover, a fourth upper half, worn and broken in front. He gives the whole three for elephants' teeth, while the real molar of an elephant (represented in plate 9) is supposed by him to be the production of some great animal unknown.

Aldrovandus may be excused, as he had no skeletons of these animals: but as his figures are easily distinguishable, and, moreover, as large as life, the error of his classification might have been easily rectified; and yet it is his testimony alone, clear and positive as that testimony is, which has been neglected by those who have enumerated the authorities for the existence of the fossil bones of the hippopotamus.

Aldrovandus does not speak of the origin of these fossils, but it is probable that, like some of those I am about to describe, they came from some of the vallies of Italy. They are at present preserved in the Museum of the Institute of Bologna, where I have been able to assure myself of the accuracy of the figures he has published.

A petrified tooth, quite similar to that of Aldrovandus, and consequently also belonging to the hippopotamus, is represented in the Museum Beslerianum (plate 31), under the simple denomination of *dens maxillaris lapideus* (petrified jaw tooth).

Hence, the specimens I here allude to were presented by Aldrovandus and Besher, without their being able to apply to them their proper designation. Camper, Merk, Davila, Lang, Faujas, Lamétherie, and, in some instances, Daubenton, have applied that designation to objects to which it did not belong. Antoine de Jussieu and Daubenton, in his numbers MCII and MCIV, are the only two possessing the double merit of presenting us with genuine specimens, and of annexing proper designations to them.

Having thus taken a survey of the labours of my predecessors, I shall proceed to detail the result of my own observations.

## ARTICLE I.

### On the Great Fossil Hippopotamus.

#### I. *Of the Places where it has been found.*

The first pieces which led to my knowledge of the existence of the fossil bones of the hippopotamus, were those just mentioned, belonging to the Museum, and pointed out by Daubenton under the numbers MCII and MCIV.

I have given a drawing of the first, plate 33, fig. 1. It is a portion of the lower jaw of the right side, containing two grinders, the last but one and the last but two. From the imperfect growth of the last grinder but one, it has been surmised that the last of all had not emerged. The last but two is much more worn than the other. In front of these two teeth is the socket of a third, some fragments of the root of which are all that remain of it. The lower edge is broken along the whole length of the specimen. The large tooth is 0,05, and the smaller 0,035 in length. The breadth of both is from 0,025 to 0,027. The corresponding teeth of the common hippopotamus are 0,005 more; that is to say, they are one tenth longer. The enamel is of a blackish dye: the osseous substance and the maxillary bone is of a deep brown colour.

The second specimen (plate 33, fig. 2) is a last but one upper molar in a medium state of detrition: besides its having become somewhat friable by its stay in the earth, it has been rolled about, and all its shapes have become rounded: the roots are broken: its enamel is yellow, and has not the black dye of the previous specimen. From these circumstances we may feel inclined to doubt of their having come from the same place, and the conjecture I threw out with regard to their origin may only hold true in the instance of one of them.

The third fossil specimen of the great hippopotamus which has come under my observation, is from the Museum of the late Joubert, at present in that of M. de Drée. I have given a drawing of it (plate 32, fig. 2). It equals the size of those of the most common li animals. It is the fragment of an upper jaw, containing two teeth that precise state of detrition in which they are most easily di



guishable by their trefoil figures and the other delineations of their crown: they are the last grinder, and the last but one of the left side. This specimen is, unquestionably, a fossil: it is penetrated with a ferruginous substance, but, like the rest, it is unaccompanied by any indication of the place of its origin. However, as M. Joubert was treasurer of the States of Languedoc, and as the duties of this office required his presence frequently at Montpellier, it is very probable that it was there he procured this fragment, and moreover that he may have extracted it from the same precise spot called Mosson, from which Antoine de Jussieu had formerly procured similar relics. When I passed through Montpellier in 1802, I inquired most carefully for all the fossils which might be in the Museums there. I examined with attention the collection of my esteemed fellow-labourer, M. Gouan, and that of the central school, which was then under the direction of the late M. Draparnaud, but without being able to discover a single fossil relic of the hippopotamus. Some time after, having seen this specimen of the collection of Joubert, I was examining a variety of fossils picked up in the Valley of the Arno, by M. Miot, at the period when he was French Ambassador at the Court of the great Duke of Tuscany, when I observed an astragalus which I was unable to refer to its species. M. Miot having had the kindness to lend it to me, that I might examine it at my leisure, I very soon discovered that it neither belonged to the elephant nor the rhinoceros; and as its large size would not admit of the supposition of its having belonged to an animal inferior to them in magnitude, I had no longer any doubt of its having formed part of an hippopotamus.

Its shape strengthened this supposition. It bore an almost perfect resemblance to the astragalus of the pig; and, of all animals, the pig is undoubtedly that whose organization approximates closely to that of the hippopotamus.

These two considerations had the effect of almost entirely dissipating my doubts; but I had the pleasure of finding a still more conclusive proof, while engaged in the construction of the skeleton of a fœtus of an hippopotamus, which I mentioned in the preceding section. There was no perceptible difference, except that of size, between the astragalus of this fœtus and the fossil, which became doubly valuable to me, as I had not then any corresponding bone belonging to a full grown animal.

Having thus obtained a positive certainty of one of the places where the bones of the hippopotamus might be discovered, I lost no time in writing to M. Fabbri, at that time director of the Royal Museum at Florence, a philosopher universally celebrated, as well for his amiable qualities as for his profound and comprehensive knowledge. I felt confident that several pieces of the same species would be found among the fossils of his Museum, and the result proved the success of my anticipations.

M. Fabbri sent me the drawings of three teeth, which have evidently belonged to the hippopotamus. I have caused these drawings to be engraved, and they are to be seen, plate 32, figs. 3 and 5, and plate 33, fig. 10.

The first (plate 32, fig. 3) is the last grinder but two of either jaw,

half worn; the second (that of plate 32, fig. 5), is the last grinder of the under jaw, in that stage when it was just on the point of emerging from the gum: as it was not used in masticating, the points of its knobs were still entire: its enamel is not cut; and this drawing may serve to show the form of the germs of the grinders of the hippopotamus, for it does not exhibit the slightest difference, except that it looks somewhat larger. I cannot say whether this is the fault of the artist or not, as M. Fabbroni has not sent me its dimensions. The third engraving (plate 33, fig. 10) represents the fragment of a tusk or lower canine tooth. This piece is also very easily recognised as belonging to the hippopotamus: no other animal has tusks of this shape: those of the elephant are larger, and are neither angular nor striated; those of the sea cow are certainly striated towards the root, but they are not angular. The tusks of the narwhalus is straight, or as it were bent spirally by the stria of the surface. The grain of the osseous substance is besides very different. In that of the elephant we may observe some brownish spots crossing each other in very regular curvilinear lozenges. In that of the sea cow there are brown veins, as it were, inserted in a white substance. The osseous substance of the tusk of the narwhalus presents a uniform appearance; that of the hippopotamus fine stria, concentric with the contour of the tooth.

With regard to this tooth, M. Fabbroni has written to me, that it differs from that of the African hippopotamus, by its diameter having a greater relation to its length, and by its spiral curve being much more decided.

He adds, that these teeth are found scattered up and down in the upper Valley of the Arno, but unaccompanied by jaws or other bones.

Notwithstanding this, the astragalus picked up by M. Miot furnished a sufficient proof that with a little attention the other parts might also be collected.

In fact, the subsequent searches were attended with better success.

When I first visited Tuscany in 1809 and 1810, I found, both in the Museum at Florence and in that of the Academy of the Valley of the Arno at Figlini, such an abundance of the fossil bones of the hippopotamus, that there was not the slightest difficulty in reconstructing a skeleton from them. Moreover, I have myself deposited in the King's Museum a considerable quantity of them, which I purchased from the peasants on the spot; and as they have continued to collect them since that time, I observe in the work of M. Breislack, that there has been a skeleton almost entire in the Museum of the Grand Duke, since 1816, along with portions of at least eleven other individuals\*. In short, it is a notorious fact, that the bones of the hippopotamus are found in as great quantities in the upper Valley of the Arno as those of the elephant, and in much greater quantities than those of the rhinoceros. However, they are found confusedly intermixed with both, in the same strata, namely, the sandy hills which form the first stages of the mountains encircling that beautiful valley.

In proportion to the diligence exercised in searching after these

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\* Breislack's Geology, p. 445.

fossil bones, has been the greater or less number of those of the hippopotamus which have been discovered.

Thus, I have seen two well characterised jaw teeth in the Museum of the University of Pisa, which were found in the lower Valley of the Arno. At Bologna, besides the teeth mentioned by Aldrovandus, I observed a fine lower head of a femur. In the Museum of the Roman College at Rome there are some tusks found in the neighbourhood of that city.

As for France, besides the pieces found in the neighbourhood of Montpellier, which I have already mentioned, some others have been discovered quite close to Paris. I have deposited, in the King's Museum, a very fine tusk extracted from the sand in the plain of Grenelle.

The Abbé de Tersan was likewise possessed of a jaw tooth found in the same quarter, and which appeared to have lain in a ferruginous white gravel.

Again, in England, Mr. Trimmer has found some at Brentford, in Middlesex. They consist of a tusk, two incisors of the lower jaw, an entire jaw tooth, and the fragment of another—all represented in the Philosophical Transactions of 1813, plates 9 and 10. They were in a large dépôt, with the bones of the elephant, the rhinoceros, and the stag, to which I have alluded elsewhere.

These facts must at once remove all doubt of the fossil remains of the hippopotamus being found in several places, in conjunction with the bones of the elephant, the rhinoceros, and the mastodon; but it is rather singular that the only country in which they have been found in quantities proportioned to those of the other species, should be the upper Valley of the Arno.

No other country has yielded more than inconsiderable fragments, and those in small quantities.

Hence it is to the specimens found in the Valley of the Arno that I shall chiefly have recourse in founding those comparisons, by which I shall prove that the fossil and the living hippopotamus differ as widely as the fossil elephant and the fossil rhinoceros, from the species of our times.

## II. *Osteological Comparison of the Great Fossil Hippopotamus with the living Species.*

The distinguishing characters of the great fossil hippopotamus are not quite so easily perceptible as those of the elephant and rhinoceros of the same time; and, as long as the relics of the former were limited in number, and I had no complete skeleton of the living hippopotamus to compare them with, I almost despaired of being able to assign any positive difference; but the uncertainty in which I found myself, at the period of the publication of my first edition, has been happily dissipated; almost all the bones, taken one by one, in the two species, show marked differences, and the geological rule relative to the strange genera is found applicable to this as to all the other species.

### 1. *The Head.*

The fossil head (plate 35, figs. 1 and 2), viewed from above, has its occipital crest narrower, the zygomatic arches less widely apart towards the rear, the portions of the skull bounded at the sides by three



arches, longer in proportion: the junction of the os malæ to the muzzle is there effected by an oblique line and not by a sudden slope; from whence it results that the contracted portion of the muzzle is shorter in proportion. Besides the differences resulting to the profile from those just enumerated, we may moreover remark that the occiput rises more suddenly, so that the fall of the sagittal crest, towards the interval of the orbits, is more rapid, and consequently the vertical height of the occiput is greater.

The fossil head represented in the plate is one of those splendid specimens that enrich the Museum of the Grand Duke at Florence.

In the *lower jaw* (plate 35, figs. 3 and 4) I find the interval of the two branches much narrower, and the angle formed by their internal surfaces less rounded in front. The slant towards the posterior inferior angle returns less rapidly towards the front, and the inferior edge also rises a little less in front, and consequently forms at that spot a less concave edge, which causes it to make a decided angle with the anterior edge below the canine, which does not exist in the living hippopotamus.

The lower fossil jaw, which is in a very good state of preservation, is also in the Museum of the Grand Duke at Florence.

I have deposited one somewhat less complete in the King's Museum.

Its dimensions are as follow:—

|  |       |
|--|-------|
| Distance from the anterior to the posterior angle .....                                  | 0,456 |
| From one anterior angle to the other .....   | 0,335 |
| From one posterior angle to the other.....   | 0,443 |
| Length of the space occupied by the jaw teeth .....                                      | 0,307 |
| Distance between the first anterior grinders .....                                       | 0,095 |
| Distance between the last grinders .....   | 0,057 |
| Breadth of the rising branch .....   | 0,155 |
| Breadth of the coronoid apophysis .....  | 0,118 |
| Height of the jaw, from the posterior angle to the articulating coronoid apophysis ..... | 0,336 |
| Length of the symphysis .....  | 0,186 |

## 2. *The Vertebrae.*

Of these I have had five, not one of which is precisely similar to the corresponding one in the living hippopotamus.

A fossil cervical of an hippopotamus, which appears to have been the fifth, with a body broader and higher by one-fourth, is not longer, and its annular part is one-third narrower: but its articular and transverse apophyses appear to have been pretty much the same.

A fourth or fifth dorsal (plate 36, fig. 12) is strongly distinguished by the base of its spinal apophyses being much broader and more blunted in front.

A thirteenth dorsal has its articulating surfaces more elongated, and one spinal apophysis directed further towards the back; a first lumbar vertebrae (plate 36, fig. 13) is only distinguished by a spinal apophysis smaller and straighter than the corresponding one in the living animal; a first sacrum (plate 36, fig. 14) has its body less depressed, and the anterior articulating apophysis larger and closer to the body of the bone.

From these data the fossil hippopotamus may be supposed to have had a shorter neck than the living animal, but the other parts of the spine must have differed but very slightly in their proportions.

### 3. *The Great Bones of the Anterior Extremity.*

*The Shoulder Blade.*—The portion in my possession (plate 36, figs. 1 and 2) differs palpably from that of the living animal, by an articulation more rounded, not pointed in front, and by a coracoid tuberosity blunted and more bent inwards.

This fragment must have belonged to an animal from fourteen to fifteen feet in height.

*The Humerus.*—I have had a drawing made of the upper head of this bone (plate 36, figs. 3 and 4), which I saw in the Museum at Florence. I brought hence about a third of the lower part, but consisting of parts belonging to two individuals. It is easy to discern, both in one and the other (plate 36, figs. 5 and 6), that the pulley of the articulation is narrower and thicker, and that the crest above the external condyle rises higher and is more prominent than in the living animal. To judge of it by the breadth between the two condyles, the largest of these two fragments must have proceeded from an animal thirteen feet nine inches in height.

The bones of the *fore-arm* (plate 36, figs. 7, 8, 9, and 10) form, as in the living hippopotamus, a single piece, and present us with the same details in their configuration; but their proportions are widely different.

Their united bulk is much larger in proportion: in the living animal, the greatest breadth of the two bones at the base is contained twice in the length of the radius: in the fossil it is contained in it but little more than once and a half.

The boundary between the two bones is not marked in the fossil by a deep furrow with sharp edges. This space is hollowed into a large concavity, filled at the bottom, with the exception of the hole piercing from side to side in its upper part, and which may be seen in the fossil as in the living animal, but much higher in the former than in the latter. Its distance from the sigmoid facette is, to the length of the radius in the fossil, as 1 to  $4\frac{1}{2}$ —in the living, as 1 to  $3\frac{3}{4}$ . The part containing the olecranon and the sigmoid facette, is larger, in relation to the rest of the cubitus, in the fossil than in the living animal.

The fossa separating the two parts of the sigmoid facette is much broader and less deep in the fossil; the anterior face of the radius is more regularly cylindrical; the lower surface of the two bones is there broader in proportion to its antero-posterior diameter: the facette for the second bone of the carpus is larger in proportion to the two others, and particularly to the first.

The *fore-arm* in our possession is 0,460 long, and 0,184 wide at the base. Its length would indicate an animal thirteen feet six inches in height; its breadth would greatly increase this proportion, and it is probable that its height was a medium between these two results, and that it exceeded fourteen feet.

4. *The Bones of the Carpus.*

*The Schaphoid Bone.*—The fossil is the highest in proportion; its articulation with the radius is distinguished by a more finished edge from the upper semilunarian: the trapezoidian facette is broader, taken transversely; that which answers to the os magnum is narrower and much more pointed at the back, so as to present a sharp isosceles triangle, while in the living it is an irregular rhomboid; these two facettes are likewise separated by a more decided edge.

I have the schaphoid bones of the carpus of both sides; they are both very strongly impressed with these characters.

From the proportion they bear in size to those of the living animal, they must have belonged to animals fourteen feet long.

*The Semilunar Bone.*—I have seen and taken a drawing of one of the left side, in the Museum of the Academy of the Valley of the Arno at Figlini; it might have belonged to an animal about fourteen feet in length. Its upper or radial surface was evidently broader and less oblique; the anterior was higher than the side next the schaphoid; the inferior cuneiformian facette was higher, and the posterior surface broader above than is observed in the analagous bones of the living hippopotamus.

*The Os Cuneiforme* (plate 36, fig. 17).—The fossil is higher in proportion; its cubital facette is not so broad, and is more concave; the semilunarian, and that for the os pisiforme, are also much narrower. I have those of both sides in a high state of preservation; the largest announces an individual seventeen feet in length.

*The Os Magnum* (plate 36, fig. 15).—This fossil differs sensibly from that of the living animal: it is higher in proportion. The schaphoid facette there, is pointed at the back: in the living subject it is broad, and loses itself insensibly; the edge separating it from the semilunarian facette is much farther back in the fossil; the semilunarian facette is there larger, and is concave behind; the facette for the unciform is there very concave; the posterior tuberosity enlarges and advances outwards, in the form of a crotchet; the facette next the inferior trapezoid becomes prolonged and enlarged towards the back, as it were in the shape of a small additional facette, of which there is no trace in the living animal; the metatarsal facette is broader towards the rear.

I have had the fossil *ossa magna* of both sides: the largest must have proceeded from an animal fifteen feet nine inches in length.

*The Os Unciforme* plate (36, fig. 11).—That of the fossil differs but slightly from that of the living animal. Its posterior tuberosity is shorter, thicker, and less bent outwards.

The internal edge of the semilunarian facette advances farther inwards.

The facette sustaining the fourth metatarsian is broader, and unites itself on a longer space to that of the third; the edge of their junction is more prominent behind.

I have only had this bone once: it belonged to an animal about seventeen feet in height.



5. *The Great Bones of the Posterior Extremity.*

*The Os Innominatum.*—I brought two ossa innominata with me from Tuscany—one of the right, the other of the left side—both almost of the same size as those of our skeleton of the living species—so much so, that by placing them on their respective sides, the differences became apparent in an instant: unfortunately the pubis is broken.

The fossil (plate 37, figs. 1 and 2), has the two wings of the os ilium more equal: the external does not exceed the other in size; the returning line, extending from the external spine to the cotyloid cavity, is inflected like that extending from the sacrum to the ischium. In the living animal the first is less inflected, thereby communicating an obliquity and a defect of symmetry to the os ilium, which are not observable in the fossil. The cotyloid cavity of the fossil is, by one fourth, larger than that of the living animal. The ischium is shorter and much thicker. Its superior margin, at the spot where it enlarges, is sharp in the living, and square in the fossil: its enlarged part is not concave inside, and the upper part of its tuberosity deviates outwards; while in the living animal it rises in a vertical direction, and is parallel with that of the other side. In general, the os innominatum of the fossil is thicker than that of the living animal.

*The Fossil Femur* (plate 37, figs. 3, 4, 5, and 6) differs, in the slightest degree imaginable, from that of the same part of the living animal. I can merely discover that the great trochanter of the latter is more pointed, and the slope separating it from the head is more profound. I have one 0,6 in length, indicating a subject nearly thirteen feet high.

*The Fossil Rotula* is higher in proportion to its breadth than that of the living animal, and more in the shape of a rhomboid. That in my possession belonged to an animal seventeen feet and a half in length.

*The Fossil Tibia* (plate 37, figs. 9, 10, 11, and 12) is thicker, in proportion to its length, than that of the living animal; which agrees with the dimensions of the fore-arm, to give us to understand that the fossil hippopotamus had shorter and thicker legs than the animal of our times; but these differences in point of shape are very immaterial: we can scarcely perceive that its inferior articulating surface is less broad from front to rear, and that its external condyle projects a little more on the outside. Its length being 0,393, would indicate a subject of twelve feet six inches; but supposing the tibia to have been shorter in proportion, we may allow a little more to the height of the animal.

6. *Bones of the Tarsus.*

*The Astragalus* (plate 22, figs. 1 and 4).—The fossil is the flatter of the two; the ligamentous fossa of its pulley is much less hollowed, and is smaller in proportion; its great calcanean process is much broader and of a quite different shape, proceeding to rejoin the tuberosity of the internal anterior angle of the inferior surface, from which it is separated, in the living subject, by a wide fossa; consequently it is much broader in this particular spot, in the fossil. In every other respect these bones bear a great resemblance to each other.

The linear dimensions of the most perfect fossil astragalus which has

fallen under my observation, are, to those of the living subject, in the proportion of 3 to 2, which would give the animal's length at sixteen feet and a half. It is that of the right side.

*The Calcaneum* (plate 37, figs. 13 and 14), has its great astragalian process larger towards the top, adapting it to the reception of that of the astragalus. I likewise find that it is more elongated in proportion to its height, for its height is, to the distance of its tuberosity from the astragalian process, as 1 to  $2\frac{1}{2}$ , while in the living subject it is as 1 to 2. The fossa for the tendon of Achilles is shorter, the tuberosity of its inferior surface is much less prominent; its third astragalian process is not so high; the cuboid process is larger; in a word, the practised eye discovers, at a glance, that it is a calcaneum of the same genus, but of a different species.

My two best calcanea belong to the left side: their total length is, to that of the living subject, as 9 to 7: they must have proceeded from a subject of about fourteen feet three inches.

*The Cuboid of the Tarsus* (plate 37, figs. 7 and 8), has its astragalian process broader behind in the fossil; it is not there separated from the fossil by so deep a slant; it is not slanted at all at its internal edge. The rhombus of its inferior surface is more oblique, and its posterior inferior tuberosity much less prominent towards the base.

I have had a very perfect one belonging to the right side; it was, to that of the living subject, as 7 to 5: the animal must have been about fifteen feet and a half; a first left metatarsal bone of a subject more than fourteen feet and a half does not offer any decided distinction; but a second right bone of the same part (plate 37, fig. 15), though equal to the corresponding one of the living animal, in length, is broader by a fifth, and its upper head is cut more into right angles.

I have a first phalange of one of the middle toes of the hind foot, which only differs from the corresponding one of the living subject, by its dimensions being greater by a fifth.

## 7. Conclusion.

It is now quite clear, that notwithstanding the general resemblance of these bones with those of the living animal, they all afford sufficient characteristics to lead us to acknowledge a difference of species, and that the great fossil hippopotamus does not prove an exception to that rule which affects the elephant, the rhinoceros, and the other pachydermata of our changeable strata.

With respect to the two other species of the fossil hippopotamus, this rule applies to them in its fullest extent, and even with more force and propriety than to the elephants, which shall be further illustrated in the following article.

## *Additions to this Article.*

Subsequently to the printing of this article, I have received the eighteenth volume of the *Memoirs of the Italian Society of Sciences*, in which I find, at page 415, an excellent dissertation from the pen of Professor Nesti, on the fossils of the Valley of Arno. This learned

naturalist, previous to his having seen my work, had himself arrived at a precisely similar conclusion, namely, that the fossil species differs from the hippopotamus of our days.

M. Nesti proves this proposition, by a comparative table of the dimensions of the heads of the fossil and living animal, which I think I am bound to lay before my readers.

The head and lower jaw represented by him are the same from which the figures of my plate 35 are taken; but he has added a pelvis, a shoulder-blade, a humerus, more perfect than those which I have had an opportunity of drawing; and in addition to these, an atlas, an axis, and some small bones which I never was so fortunate as to obtain.

Hence his shoulder-blade is complete, with the exception of a slight deficiency of the coronoid tuberosity. It presents no sensible difference from my shoulder-blade of the living animal, except it may be a somewhat greater width towards the middle of the spine. Its humeral articulation is quite as round as it is in the living animal, while mine is more oblong. Can this have proceeded from some mutilation effected in either of them? It is quite clear, from an inspection of his humerus, that that bone is much thicker in the fossil than in the living animal—a fact already pointed out by my two fragments. The excess in the height and thickness of the fore-arm is also easily distinguishable in them.

As for the vertebræ, I could not venture to form a comparison between them, upon the strength of figures alone, as those of the fossil animal may have been mutilated and deformed.

It is but a short time since some teeth of the hippopotamus were found in the cavern at Kirkdale, in Yorkshire.

#### *Head of an Hippopotamus found in England.*

Mr. Buckland, in his *Reliquiæ Diluvianæ*, (plate 22, fig. 5), copies a figure of the head of an hippopotamus, published by Lee in his *History of Lancashire*, printed at Oxford in 1700, which, according to the latter author, was found in that county, beneath some moss—probably meaning peat.

#### *Bones of the Hippopotamus found in Tuscany.*

I cannot refrain from recording in this place the debt of gratitude which the Museum owes to his Imperial Highness the late Grand Duke of Tuscany, for the presents of fossil bones which that prince, in his anxiety for the promotion of scientific knowledge, sent us a short time before his death. He has thereby furnished us with an almost complete series of the bones of the fossil hippopotamus. Amongst them is a head, a lower jaw, and a pelvis, which are scarcely deficient in a single particular. These splendid specimens are decisively confirmatory of the striking resemblances which both M. Nesti and myself had pointed out as causing the fossil to approximate so closely to the living hippopotamus, at the same time that we noticed the slight differences which distinguish them. It is solely from a disinclination to swell the number of plates, which already encumber this work, that I abstain from representing these precious objects.



## ARTICLE II.

## On the Small Fossil Hippopotamus.

In the programme of the present work, printed at Baudouin in 1797, by order of the first class of the Institute, I announced in very brief terms the existence of this species, as remarkable as it is new.

The brevity of that notice was pronounced by some naturalists to border on obscurity\*. The details upon which I am about to enter at present, will, I feel confident, obviate this defect.

The block from which I derived this species had lain so long in one of the magazines of the Museum, that nobody could be found capable of giving an account of its origin: however, it struck me, by the quantity of bones and teeth with which it was as it were larded on every side, that it bore a great resemblance to the osseous slabs of Gibralter, Dalmatia, and Cette, except that the paste, instead of being composed of calcareous and stalactitical substances, was a sort of freestone, calcareous at bottom, uniformly filling all the intervals of the bones; and that they formed a proportion incomparably more considerable of the whole mass, than they did in the slabs just mentioned.

This dross, when examined by M. Brongniart, was found to be composed of two-thirds of carbonated chalk: upon thirty of these parts there were nine of sand, mixed with a little clay.

Considerable time and patience were expended in disengaging a part of these bones from the stone which encrusted them. To effect this, we laboured for several days with the chisel, the file, and the augur, and we found ourselves under the necessity of sacrificing many, in order to preserve some entire: but we were amply rewarded for our trouble, by at length bringing to light the remains of an animal of which nobody but ourselves had ever entertained the slightest idea.

A considerable time now elapsed, without my being able to meet with any stone similar in substance to the preceding. At length, happening to pass through Bourdeaux, in March, 1803, I paid a visit to the fine Museum of Natural History then belonging to the senator, M. Journu-Aubert, and which he has since bequeathed to his native town. Here I recognized, at the first glance, a block quite similar to that which I had taken to pieces in the Museum: but unfortunately, it was also without any references as to the place from which it had been extracted; and neither M. Villers Professor of Natural History at Bourdeaux, who had the care of this collection, nor M. Journu-Aubert himself, who happened to be at Bourdeaux presiding over the electoral body, could give me any information on the subject. M. Journu-Aubert has since most generously presented this precious specimen to our Museum, and has thus enabled me to perfect the knowledge of this remarkable species, by the addition of other bones to those which had been furnished by the first.

From these blocks I have extracted jaw teeth of various descriptions, some canine and some incisors: fig. 7, plate 32, represents one of the largest of these jaw teeth. Its crown is elongated, and presents

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\* Faujas, Essay on Geology, vol. i, p. 366.

at first a small transverse part, *a*; then a pair of knobs, *b c*, separated by a deep valley from another pair, *d e*, which are also separated by another valley from a simple knob, *f*. Mastication has only worn these knobs on their anterior surface, and very obliquely; a circumstance which shows that the knobs of the opposite tooth penetrated into the intervals of the latter during the process of mastication.

This constitutes in itself a difference from the ordinary hippopotamus; but in other respects all the other essential characters meet in this tooth as much as in the last tooth but one of the lower jaw of that great animal;—the same four knobs in two pairs; the same isolated knob behind; the same small transverse prominence in front. If the trefoil figures are not perfectly distinguishable, this is owing to the oblique manner in which detrition takes place: it effaces the longitudinal furrows of the knobs, and only leaves some traces of them behind. A little of this trefoil figure is seen in *b* and in *c*.

This tooth is 0,033 in length, and 0,016 in breadth.

In the block of M. Journu-Aubert I found the germ of this same posterior tooth. It is represented plate 34, fig. 7.

Another of these teeth, plate 32, fig. 6, is almost square at its base, which is entirely surrounded by a salient collar, upon which arise two pairs of knobs, or rather two transverse knobs forked at their summits, and marked with furrows on their surfaces; so that, if detrition had been conducted horizontally, it would most certainly have produced trefoil figures; but although it is only just begun in this particular tooth, it is already easy to perceive that it takes place obliquely. The points of the two knobs in front, *a b*, are only slightly worn into the shape of a triangle, and yet the part adjoining the collar *c* is also a little blunted; which proves that the salient parts of the opposite tooth penetrated into the cavities of the latter.

This tooth is 0,027, both in length and breadth, at the circumference of its base.

A third tooth, similar to the preceding, but smaller and more deeply worn (two proofs of its having been placed more in front), is represented plate 32, fig. 8; its square measures but 0,02; its two first knobs, *a b*, have already confounded their osseous discs, owing to the effects of detrition; the other two, *c d*, present as yet but two separated triangles.

Fig. 3, plate 33, is the germ of a tooth, which in time would have become similar to the preceding. It has not emerged from the gum, neither has it got a root, nor is its summit in the slightest degree impaired: we may there see how the two transverse knobs are both rendered forked at their summits by two planes, making together an angle of about sixty degrees.

The resemblance of this germ to a similar one of the common hippopotamus, must strike the least attentive observer: it is larger than that of the worn teeth, because it is the way in which detrition is effected which causes all the difference of shape between the two species.

The base of this germ is 0,023 square: that of the germ of the common hippopotamus, which I have compared to it, is 0,05, that is, more than double. Neither is it so perfectly square, and the posterior knobs are somewhat shorter than the rest.

Here, then, we have the last molar of the great hippopotamus, as well as the two that precede it, most accurately represented in the small one. There is no other animal whose germ can stand the same comparison, if we may except the pig: its three last grinders are almost equal to this in size: moreover, the two first have four and the last has five knobs; but these knobs are furrowed all round, and are accompanied by smaller knobs or accessory tubercles; so that the crown of the tooth appears entirely covered with papillæ, which is not the case in my small fossil hippopotamus.

From what I have stated in the preceding section, we may bear in mind, that the three front grinders of the hippopotamus vary in form and simplicity of shape from the three last; we shall find the same differences subsisting in the corresponding teeth of the smaller hippopotamus.

One of them may be seen, plate 32, fig. 11. It is pyramidal, has two thick roots, and, like the grinders, is worn obliquely on its back surface, and at its point. Its base is 0,017 in length, and 0,013 in breadth. The height of its body, without the roots, is 0,015. A second is represented, plate 32, fig. 10: it is smaller, conical, compressed, and worn on its summit alone. I have another of the same description.

These anterior grinders, while bearing a strong resemblance to those of the hippopotamus, have nothing in common with those of the pigs, which are compressed, and which have a denticulated edge.

But the best characterised teeth of the ordinary hippopotamus are the incisors and the canines; and it is with reference to these that our small fossil species exhibits a perfect analogy with the great.

Thus the lower incisors are cylindrical, ranged obliquely in front, and worn only at their denticuli: I have found many similar to them (the size excepted) in the stone blocks which I took to pieces: one of these, almost perfectly entire, may be seen at plate 33, fig. 7. Its diameter gives 0,01, and its length, as it is at present, 0,08. It corresponds with one of the lateral incisors of the common hippopotamus, for the diameter of the latter gives 0,023, and the length 0,015. They are more deeply striated on their surface than those of the smaller species, their point is also more sharpened by detrition.

Although the different species of pigs also have their lower incisors very long and directed outwards, there is no possibility of confounding them with those of my animal, because they are not cylindrical, but prismatic or compressed at the sides.

The lower canine teeth of the hippopotamus are inflected, so as to form the arc of a circle. They are obliquely worn on the points of their concave surface.

My stone blocks have yielded me many of a similar description. I have represented one of the best preserved in plate 33, fig. 11. It bears a direct relation to the others in its proportions, for it has also one half of the dimensions of the corresponding tooth of the great species, viz. 0,02 in its great diameter, &c. Its surface offers some differences; the canines of the great hippopotamus are striated, or rather deeply channelled along their entire length: the latter are very delicately striated, and present, on their external surface, a hollow, or species of very wide and very shallow canal, stretching along their entire length.



These teeth might be more easily confounded than the others with the analogous teeth of the wild boar; nevertheless, they may be distinguished from them by their angles being more blunt and their curves more decided.

The upper canine teeth of the hippopotamus leave room for less doubt, as they are more obliquely worn on the side of their convexity, rounded off in all parts, cut by a deep longitudinal furrow on their internal surface, and by a slighter one on their external surface; they do not resemble those of any other animal. My little animal has furnished me with a well characterised section of one of these: it is the end of the tooth; we may there observe the two furrows, and the surface produced by detrition. The dimensions are again precisely one half of those of the living species. (See plate 33, fig. 6).

Fig. 9 is a fragment which appears to me to have belonged to an intermediate upper incisor: however, it shows a difference from that of the ordinary hippopotamus. The worn part, *a b*, is here convex, while it ought to be concave.

The furrow, *b c*, does not exist in that of the hippopotamus.

In addition to this, I give (fig. 4, plate 33) the germ of a grinder, to which there is no corresponding germ in the ordinary hippopotamus. It presents two knobs, the second of which is forked; consequently it has three denticuli, all very sharp. This is one of the anterior molars, which this small hippopotamus must have had more complicated than the living species. It is 0,02 in length, and 0,01 in breadth at the back.

I was too firmly convinced of the immense influence which the form of the teeth must exercise over the rest of the organization, not to feel persuaded before hand, that all the other bones of this animal would bear the same resemblance to the corresponding bones of the common hippopotamus, as that observed in the teeth; however, I felt extremely gratified to have it in my power to give the world a new proof of the infallibility of those general laws of zoology; and I used the utmost diligence in disengaging those portions of the bones in which I perceived the remains of characteristics.

Every one of them, without a single exception, furnished a confirmation of what had already been announced by the teeth.

Thus, the fragment of the lower jaw (plate 33, fig. 8), although very much mutilated, is not too much so, not to be easily distinguishable by itself. We may observe at *a*, that the inferior edge begins to descend, in order to form that crotchet which is so characteristic in the lower jaw of the hippopotamus; and, at *b*, we may observe that the slope between the coronoid apophysis, *c*, and the condyloid, which is wanting in this fragment, must have been of very inconsiderable depth, as is the case in the hippopotamus. The salient line, *d*, the different convexities, concavities, and flat surfaces of this specimen, are in a word identical with those of the same part of the large animal with which I have compared it. The distance of the edges from *a* to *d*, is 0,045. The hippopotamus, measured in the same place, gives 0,12, that is two and two thirds more.

I have found, in the block of M. Journu-Aubert, another portion of a lower jaw, more important than the former in many respects (plate 34, fig. 3): it is that of the opposite side. It contains the last tooth,

*a*, almost entire; but what particularly enhances its value, is, that it displays a much greater portion of the crotchet, *b*, and particularly a portion of its posterior edge; for the whole line, *c d*, is entire, and without a fracture; we may there see that this crotchet is stretched farther backwards than in the living hippopotamus, and that that portion of the jaw, instead of describing about the fourth of a circle, or the half of a crescent, must form a sort of lunula. I have marked with dots the contour which may be ascribed to that part, forming my judgment on what has remained entire.

Although this difference of configuration presents in itself a very evident specific difference, the whole is not a less strong confirmation of generic identity. As the common hippopotamus is the only known animal which has this crotchet, we might be prepared to expect that, in the event of the discovery of some other species of hippopotamus, this characteristic would likewise be found; but it is not by any means requisite that it should have the same proportions.

These two fragments of jaws must then have been recognised at once as having proceeded from an hippopotamus, even though the numerous teeth which accompanied them had never been subjected to our inspection.

This is also the case with a third fragment, represented at plate 34, figs. 6 and 8, which is also taken from the block of M. Journu-Aubert. It forms the third anterior of the lower jaw of the left side, and must have belonged to a very young subject; for on breaking it we only found the germ of a canine tooth, still very hollow inside, and contained in a socket larger than itself. Nevertheless, this square form of the front extremity, which belongs to the lower jaw of the hippopotamus, and to that animal alone, manifests itself clearly in this specimen. The holes, perforated on the external surface to allow the exit of the maxillary nerves, are placed in the same spot as in the common hippopotamus.

The lower head of the humerus (plate 33, fig. 5), offers a simple pulley at *a*, with a slight lateral excavation towards *b*. At this point it resembles that of the pig; but this second excavation would be much stronger in the latter animal. It bears a further resemblance to that of the pig, by the hole *c*, produced by the pressure of the olecranon in the extension.

Another part of the humerus, much more considerable and in a better state of preservation (plate 34, fig. 2), was most decidedly distinguished from the humerus of the pig by its sharp line, extremely prominent on the outside, and commencing very low, precisely as it may be seen in the humerus of the common hippopotamus. (See the osteology of the living hippopotamus, plate 31, figs. 7 and 8, *c*).

This portion, which only constituted two-thirds of the bone, was 0,13 in length. The two condyles were mutilated, so that it was impossible to measure their distance from each other; but the transverse breadth of the articulating pulley was 0,045. I have found it 0,097 in the full grown animal, that is, a little more than double its thickness. The lengths are in general a little more than double.

The astragalus (plate 32, fig. 9) extracted from the block found in the Muséum, is, if possible, still more characteristic. The edge, *a*, dividing the inferior part into two pulleys of equal size, at once determines

it to belong to the species of the hippopotamus alone. The other animals which have a similar division, namely, the ruminants, the pig, the rhinoceros, and the tapir, have the two pullies very unequal. The giraffe has not even a cuboid.

The length, *b c*, of this astragalus, the only one of its dimensions that has remained quite perfect, is 0,040. The same dimension, taken in the astragalus of the large living hippopotamus, is 0,77.

I have moreover extricated a scaphoid bone from this block. It measures 0,03 from front to rear; 0,02 from right to left; and it bears, on its metatarsal surface, three articulated facettes, a large, a middling, and a very small one, which proves that this small hippopotamus had, like the large one, four toes, and the vestige of a fifth on its hind feet.

The block has likewise yielded me a portion of a thigh (plate 34, fig. 1), which has lost its head, the top of its grand trochanter, and almost one third of its lower part; but we plainly perceive in it the deep cavity hollowed out on its posterior surface, between the head and the great trochanter, the extreme projection of the roof of the latter, and the position of the small trochanter at the base, and in the lining of the root of the large one.

As these characters, which I have displayed in my figure of the femur of the living hippopotamus (plate 31, figs. 15 and 16) are also to be found almost exactly the same in the wild boar, they do not afford us such positive distinctions as the others; but at the same time there is nothing to contradict the results of our previous reasoning.

The fragment of the pelvis, represented in profile, plate 34, fig. 4, and in front, fig. 5, is in the same predicament. The edges of its cotyloid cavity are broken all round, so that it cannot be measured exactly: but it is easy to see that it must have corresponded with the femur represented beside it (plate 34, fig. 1). The flatness of the os ilium, on its anterior surface, is also very similar to that displayed by the same part of the living hippopotamus. (See its osteology, plate 31, fig. 14).

I have not procured any of the other bones of this small hippopotamus; but all zoologists will agree that there are quite sufficient to characterise it. Neither is there a necessity for proving that it is full grown, and that the smallness of its size is not owing to its age: the state of its dentition and ossification is a sufficient demonstration.

Here, then, we have another species, evidently distinct from all those known on the surface of the globe. But it may be urged against this as against many others, that perhaps I am constructing an edifice whose parts nature never intended should approximate: that it may be that I am forming an imaginary animal from the bones of several animals contained in these blocks; but I am always ready with my answer. I will not stop to show the natural affinity of these divers bones, nor to prove that, taken in the aggregate, they agree most precisely with the laws that preside over the organization of animals: no; I take my stand on this unassailable ground, namely, that each bone, taken separately, differs from those of all known animals; that it is not on their combination that I establish my characters, and that if, by chance, it were to be discovered that I had actually united different species, this would in itself go to increase the number of fossil species, which, as far as our knowledge goes, do not exist at present.



*Addition to this Article.*

At the period of the reprinting of this article, I was still in the dark as to the origin of the blocks containing the remains of this remarkable species. M. Graves, who was for some time joint superintendant of the Museum of Natural History at Bourdeaux, has since transmitted to me some positive information on this subject, which he discovered in an old catalogue of the Museum of M. Journu-Aubert.

Of the two blocks in question, that which belonged to the collection of that gentleman, as well as another, which still forms a part of it, were picked up between Dax and Tartas, in the department of Les Landes, and sent by the late President de Borda to the grandfather of M. Graves, at whose death they passed into the possession of his uncle, M. Journu-Aubert.

It is beyond a doubt that the other block, which had lain so long in the King's Museum, must have been found originally in the same place; the identity of the dross, the intimacy subsisting between De Borda, and Buffon, and Daubenton, to whom he had sent several other curious fossils, almost amount to a positive certainty. Hence, it is in the department of the Landes that we may hope to recover the other remains of this highly interesting animal.

I have also recovered, a short time since, two well characterised bones of this small hippopotamus; namely, an astragalus similar to that I have just described (plate 32), and a bone of the metatarsus, the third of the left side. The latter, also, bears as strong a resemblance as it possibly can to that of the great living hippopotamus; but it is only one half its length. The astragalus is 0,039 long, and its pulley next the tarsus is 0,033 broad. The bone of the metatarsus is 0,058 long, and 0,19 broad in the centre. For an acquaintance with these two interesting specimens I am indebted to MM. Lajonkaire and Basterot, who recognised them in the Museum of M. Decken, at Brussels, and prevailed upon that learned man to confide them to me.

## ARTICLE III.

*On the Middle Sized Fossil Hippopotamus.*

The remains of this animal have been discovered and presented to the King's Museum by M. Dubuisson, Superintendant of the Museum of Natural History at Nantes.

They were found at Saint Michel de Chaisine, in the department of the Maine and Loire, in a soft sandy stone, having all the appearance of being a fresh water production.

The piece, which I have represented at half its natural size (plate 38, fig. 9), is a fractured portion of the left side of the lower jaw, containing the last molar and the last but one, the roots of the antepenultimate, and some remains of the socket of that which preceded it. M. Dubuisson has further sent a penultimate molar tooth belonging to the right side, which had fallen from its socket.

The portion of the jaw is broken below, so as to discover a part of the maxillary canal, and two of the conduits opening on the chin holes, as well as those conducting the nerves towards the canines and

the incisors. It is also broken above, so as to give but a very imperfect view of the curvity terminating at the symphysis.

The dimensions of these two entire teeth, and of all the parts of this jaw, which may be determined with accuracy, are such as to leave no room for doubting of their belonging to an hippopotamus of a much smaller species than that of our times.

The last molar is 0,03 long. In a living hippopotamus of ordinary size it is 0,064; and in the fossil jaw of our Museum, 0,085. This last dimension is almost triple. The penultimate is 0,028 long; in the living hippopotamus it is 0,058; in the fossil it is not sufficiently entire to admit of accurate measurement.

Taking the bases of the three teeth we have 0,07: in the living we find 0,17.

Besides their smallness, these teeth have characters derived from their formation:—

1st. They have no collar or prominent border round their base.

2nd. The discs of their crowns do not represent trefoil figures so distinct as those of the hippopotamus; they are more like lobes, broad on the outside and a little slanted, than like trefoil figures.

3rd. The last has not so longitudinal and so simple a fang as the last tooth of the common hippopotamus, but merely three tuberosities, forming a transverse fang, as in the penultimate.

These pieces do not greatly exceed in size the corresponding pieces of the small hippopotamus; but as they do not bear a greater resemblance to them than to those of the large hippopotamus, no doubt can be entertained of their constituting a particular species, and their relations with the hippopotamus are quite strong enough to warrant us in referring their species to that genus.

Nevertheless we cannot look upon this assertion as demonstrated, until we shall have been fortunate enough to find the canines and incisors of this species\*.

#### ARTICLE IV.

##### *On some Teeth which indicate a Species allied to the Hippopotamus, and Smaller than the Pig.*

These have been found with the teeth of crocodiles, twenty feet deep, in a calcareous bank near Blaye, in the department of Charente. I am indebted for them to M. Jouannet of Bourdeaux.

Two of these (plate 38, figs. 12 to 17) present a well defined trefoil figure on one side, although worn very low.

A third (figs. 18 to 20), worn lower still, presents two figures with four lobes.

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\* M. Cristol, of Montpellier, having discovered a jaw of this fossil species, has ascertained that it could not have belonged to an hippopotamus, and that its shape seemed to claim an affinity with the *trichecus dugong*, from which however it differed in the shape of its teeth. Hence we may conclude that this middle sized hippopotamus does in reality present the characters of a new genus, approximating perhaps to the *trichecus dugong*.

The two first have 0,018 in length and breadth : their crown is 0,01 high : the third is of the same length as the foregoing, but it is only 0,014 broad.

The enamel of these teeth is of a reddish tint, and is still very brilliant.

Their shape, as we may observe, bears a strong resemblance to those of the hippopotamus ; however, I must state with respect to them, as with respect to those of Nantes, that we must await the discovery of some other bones before coming to any definitive judgment.

An additional circumstance, which causes me to pause, is, that besides the teeth of the crocodile, there were some sharp incisors found in the same spot ; which, if they belonged to the same jaws as these teeth, would indicate a much closer affinity between this animal and one of the genera which I discovered at Montmartre, and which I shall describe in the ensuing portion of this work.



## CHAPTER IV.

## OF THE BONES OF THE RHINOCEROS.

THE genus of the rhinoceros, extraordinary as that animal may appear to those who see it for the first time, is a little less isolated in living nature than that of elephants. It is obviously connected, with respect to its osteology, with the damans, tapirs, and horses; and among fossils there are several other genera, which resemble it in some of their parts.

The fossil bones of the rhinoceros, somewhat less numerous than those of elephants, are found, however, to be very abundant. Both have been discovered in the same countries and in the same places; but the teeth of the rhinoceros, being smaller in size, have not been so often remarked. These animals have not, like elephants, those enormous ivory tusks, which must always insure them particular attention; and it is probably from these circumstances that fragments of this genus have been less carefully collected, and that mention has been made of them less frequently in the works of naturalists.

Besides, before my time, people had not such abundant resources for the study of those bodies as for that of the bones of elephants. However defective the figures and descriptions of the latter might be, they were however in existence; whilst with respect to the rhinoceros, nothing was known but the osteology of his head; even that was known, but a very short time; and even what was known, was far from being reduced to clear terms.

In fact, when Pallas, in the thirteenth volume of the *Novi Commentarii* of Petersburg, in 1769, published an account of the fossil remains of rhinoceroses found in different parts of Siberia, he expressed his regret at not finding in any of the works of naturalists a description of the osteology of the living rhinoceros, and particularly of his cranium.

Camper soon had an opportunity of procuring for him what he wanted; he addressed to the Academy of Petersburg a description, and some figures of the head of the two-horned rhinoceros of the Cape of Good Hope. His paper was inserted in the first volume of the *Acts* for the year 1777, part ii, which was not printed till 1780.

This great anatomist had not then any knowledge of the differences of teeth which characterise the two rhinoceroses; and as he had not found any incisors in his two-horned species, he accused Parsons, Linnæus, and Buffon of error, of having attributed them to the one-horned species.

But at the very time that preparation was making to print his *Memoir*, he came to Paris, and observed the one-horned rhinoceros, which then lived in the menagerie of Versailles; he recognised its incisor teeth; he procured also the head of a young one, and made a drawing of its

alveoli: he sent an account of these facts to Pallas, early enough to have them printed with his principal memoir.

He stated the same facts in his Dutch dissertation on the two-horned rhinoceros, published in 1782, the figures of which were the same as those addressed to the Academy of Petersburg.

He confirmed them in 1785, when he again made a drawing of a head of a one-horned rhinoceros at the British Museum; and having himself procured an older one than he had at first, he had it engraved, in 1787, by Vinkeles, with his former figure of the two-horned one, in a splendid plate in folio, dedicated to James Vandersteeg—a plate which he did not publish, but of which he only gave some copies to his friends. I am indebted for one to the friendship of his late son.

This figure of the head of the one-horned rhinoceros is imperfect, in as much as several ligaments still cover the true forms of the bones; there is one in particular behind the orbit, which might deceive persons not well experienced in the matter, and which might pass for a bony septum which separated this fossa from that of the temporal bones.

Still M. Blumenbach had this plate copied in a small size in his collection of figures of natural history, first part, No. 7.

In fine, M. Faujas had a drawing made, in small size, by Marechal, of the bony head of the adult skeleton of the one-horned rhinoceros in the Museum, and had it engraved in the tenth plate of his *Essay on Geology*; but this figure is no more accompanied with descriptions than that of Camper; besides, though tolerably correct on the whole, it is rendered confused with rugosities of too marked an appearance, by the engraver, and there are no sutures to be seen in it.

If to what I have just said we add the excellent figures of the lower surface of the cranium, and of the lower jaw of the two-horned rhinoceros, given by Merk, which are also without any description, in his third letter on fossil bones, printed at Darmstadt, in 1786, we shall have, I think, the complete resumé of the materials published previously to my first edition, on the osteology of this remarkable genus of quadrupeds; and it is seen that I did not fail to resume this subject, and to treat it with an extent proportioned to its importance.

I shall then be obliged, as in the case of the elephant, to give first, by way of comparison, the osteological description of the living species best known. I shall then pass on to the distinction which exists between the living species, and to the characters by which they may be known; and it is only then I shall be able to compare the fossil bones to them, and to determine whether they belong to one or several of them, or to unknown species.

The proportions which are to serve as the basis of my descriptions, are—

1st. The fine skeleton, prepared by the late Mertrud, of the one-horned rhinoceros of India, which lived for twenty-one years in the menagerie of Versailles, the same that was seen alive by Peter Camper, and of which Buffon has spoken in his supplements\*.

2nd. The head of a one-horned rhinoceros of Java, for which our Museum is indebted to the generosity of the late Adrien Camper, and which is precisely that which has served as the original for the plate of his illustrious father, but which I divested of its ligaments.

3rd. The jaw-bones of a very young one-horned rhinoceros, also of Java, already represented by Camper, and which I saw and had a drawing made of it anew in the cabinet of his son at Klein-Lankum, near Francker, in Friesland.

4th. The skeleton of the one-horned rhinoceros of this Java species, an adult, which M. Diard, a correspondent of our Museum, has just sent us from that island.

5th. The head of a two-horned rhinoceros, which is also that of a young one, which has been for several years in our Museum. And,

6th. The entire skeleton of an adult two-horned rhinoceros, recently brought from the Cape by M. de Lalande.

To these materials I shall add those supplied me by the Memoir of M. Bell, on the rhinoceros of Sumatra, inserted in the Philosophical Transactions of 1793, part i, page 3; and a manuscript Memoir of M. Diard and Duvancel, on this rhinoceros and on that of Java.

## SECTION I.

### OF THE LIVING RHINOCEROS.

#### ARTICLE I.

#### Osteological Description of the One-Horned Rhinoceros of India.

##### 1. *The Head*.\*.

What is most striking in the form of the head of the one-horned rhinoceros of India, is the pyramidal projection of his cranium; the occipital bone forms its posterior surface; the temporal fossæ form the sides; the obliquely ascending continuation of the forehead the anterior surface; instead of a point, the summit is a transverse line.

The occipital bone ascends obliquely from behind forwards, which is peculiar to the rhinoceros, and renders its pyramid almost straight. Even the hog, which has a pyramid nearly similar, has it inclined backwards.

To this elevation of the back part there is added, in order to render the profile of this animal perfectly distinct, a marked concavity above the eyes, as also nasal bones of an enormous thickness, very massy, and leaving between them and the intermaxillary bones a high and deep fissure.

The contour of the occipital bone is a semi-ellipse, which widens

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\* Besides the figures of heads of rhinoceroses which we give, after nature or copied, in our plate 42, the reader may consult Spix, *Cephalogenesis*, plate vii, fig. 21, for the one-horned; and Sparman, *Voyage to the Cape*, French Translation, tom. ii, plate iii, for the two-horned.



towards its base, in order to produce a projecting plate behind the foramen of the ear and the posterior base of the zygomatic arch.

The line of the base presents towards its middle the condyles, and at the sides the mastoid processes, pointed and hooked; in the hog these processes are precisely under the occipital condyles.

In front of each of these processes there is another very large one, which belongs to the temporal bone, and which contributes to the formation of the articulation of the jaw; it prevents it from moving much from right to left, and corresponds with a fissure situated at the inner extremity of the maxillary condyle.

Between these two processes, but a little more interior, is another short process, the end of which is hollow, and receives the styloid bone.

The impressions of the muscles divide the occipital or posterior surface of the pyramid into four fossæ. The anterior surface descends, whilst it widens as far as between the eyes, where the post-orbital processes of the frontal bone are its most widely separated limits. It becomes narrow without terminating completely in a point, because the two temporal ridges do not unite even in the old animals, and they go each separately to join the occipital ridge. The point of the nose completes the formation of the rhomboid which characterises the upper surface of the entire cranium. The region between the eyes is concave in the longitudinal direction, and plane in the transverse; that of the bones of the nose is convex in every direction.

The parietal bones commence a little before the summit of the pyramid; they terminate towards the middle of the space between this crest and the orbital processes. The frontal bones terminate a little before the processes, by uniting to the bones of the nose by a transverse suture, which passes from one lachrymal to the other. Their suture with the maxillary bones sets out from the same point, where the preceding meets the lachrymal. The sutures corresponding to the coronal and lambdoid are perfectly transverse. This latter is anterior to the occipital ridge.

The squamous suture, or the limit of the parietal and temporal, in the fossa of this latter name, is parallel to the direction of the anterior surface of the pyramid. The great ala of the sphenoid bone ascends but a very little way into the temporal fossa, and this bone does not articulate with the parietal. The palatine bone ascends therein by a very narrow slip, and then goes forwards towards the lachrymal bone, by a slip, which is also very narrow.

The lachrymal bone advances more over the cheek than into the orbit, and has a hook at the edge of the orbit, behind which is the foramen. The frontal bone has scarcely any post orbital projection.

More than half the zygomatic arch behind belongs to the temporal bone; all the remainder belongs to the malar bone.

The malar bone passes over the cheek, where it is articulated with the lachrymal.

The direction of the arch is like an Italian *S*, descending obliquely from behind forwards: its lower edge is very thick and very projecting. There is a very slight inferior postorbital prominence, in the formation

of which the malar, temporal, and the maxillary bones concur almost equally.

The maxillary bone advances under the orbit, and forms a floor there: it has no apophysis, either frontal or malar, to join the zygomatic arch to the frontal, and to close the orbit behind.

The suborbital foramen is small, more high than broad, and near the bottom of the nasal fissure above the first molar tooth. The suborbital canal is long and narrow; it opens behind above the fifth molar tooth.

The maxillary bones form in front a projecting apophysis parallel to the nasal bones, and situated under them, which articulates with the incisors. The alveoli of the incisors form together an angle of more than eighty degrees. The foramen incisivum is very large, elliptical, and not divided into two; one half of its length is in the maxillary bones.

The incisive bones are directed to the extremity of the anterior apophysis of the maxillary bones, with an ascending or palatine apophysis. At their upper edge is a small apophysis in the form of a square plate, which rises towards the roof formed by the nasal bones, and which should be remarked so much the more carefully, as it constitutes one of the characters of this species.

The nasal bones have a size and thickness, of which there is no instance in the other quadrupeds; they form a vault, which slopes over the incisive bones, and carries the horn. In our animal, their upper surface is like a head of cauliflower.

Between them and the incisive bones, as also the part of the maxillary bones which carry the latter, is that great nasal fissure which characterises, at the first glance, the cranium of the rhinoceros. The consequence of the depth of this fissure is, that in this animal three pairs of bones, the nasal, incisive, and maxillary bones, contribute to form the contour of the external openings of the nares, whilst in other quadrupeds it is only the two first that do so, except the tapir.

The vomer is ossified only in its most posterior part, and there remains nothing in the four-fifths of its length, even in our perfectly adult rhinoceros, and where all the sutures were effaced. This remark is essential for comparing living with fossil rhinoceroses.

The posterior fissure of the palate is very deep, for it advances to nearly opposite the fifth molar tooth. The suture which separates the palate bones from the maxillary bones corresponds to the interval between the fourth and fifth molar tooth.

The pterygoid processes are short in the longitudinal direction, but very high in the vertical, simple and only a little forked towards the end.

The middle part of the sphenoid bone is narrow, and goes much more posteriorly than its pterygoid wings; its articulation with the basilar part of the occipital bone forms a very perceptible projection. Along the middle of this basilar part is a projecting ridge, which widens and flattens towards the lower edge of the occipital foramen.

The rocher is small and very irregular; the foramen lacerum is large, and extends the entire length of the inner edge of the rocher. The gle-

noid facette is transverse, a little concave, not limited posteriorly, except on the inner side, by a large process of the temporal bone, of which we have spoken already, placed beneath the foramen auditorium, and which is much more prominent than the tubercle placed behind this foramen, and even than the mastoid process of the occipital bone. The foramen auditorium sinks horizontally behind the posterior base of the arch.

The foramen analogous to the spheno-palatine opens near the fifth molar tooth in the palatine; that corresponding to the pterygo-palatine, a little more posteriorly over the union of the palatine and maxillary.

The anterior orbital foramen is small, as is the foramen opticum; but the spheno-orbital, which comprises also the foramen rotundum, and is concealed behind a ridge of the bone, is large.

There is a vidian foramen at the base of the ala. The foramen ovale is confounded with the foramen lacerum.

## 2. *The Teeth.*

Independently of the importance of the teeth in general, in order to attain a knowledge of the nature of animals, and particularly for the determination of fossil animals, we must necessarily enter into some detail regarding the teeth of the rhinoceros, because the late M. Faujas, in his *Treatise on Geology*, has endeavoured to perplex this subject. We shall first answer his remarks\*.

All rhinoceroses have seven molar teeth on each side, above and below; twenty-eight in all.

A head of a two-horned rhinoceros in our Museum exhibits, to be sure, but twenty that are apparent (plate 40, figs. 1 and 2), by reason of the youth of the animal to which they belong; but anatomists are not deceived in cases of this kind, because they know how to find in the sockets of the jaw bones the germs of the teeth which have not yet appeared; and these germs existed accordingly in this head, which would have had twenty-eight, as all those of its species, if the animal had not been killed too young.

The head of the adult skeleton of the two-horned rhinoceros which was brought hither some little time ago, has twenty-eight molar teeth, precisely as all the others. (See plate 56, fig. 2).

The skeleton of a one-horned rhinoceros, which forms the principal object of our present description, exhibits, on one side of its lower jaw, six teeth or stumps of teeth, and on the other (plate 40, fig. 4) the appearance of seven; but that is a slight illusion, which cannot deceive those who have studied the growth of teeth.

All herbivorous animals, to commence with the horse, use their teeth to the root, because in proportion as the crown diminishes by trituration, the alveolus becomes filled and forces the root out. When this root consists of two branches, as in the rhinoceros, and the stock of the tooth has been entirely worn, there remain two stumps of root: these stumps fall one after the other, constantly diminished by trituration, and pushed out by the growth of the bone within the alveolus. At last the alveoli themselves are entirely effaced.

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\* Faujas, *Essai de Geologie*, t. i, pp. 193—196.



This partly happened to our rhinoceros; he had already lost his first molar tooth on each side, and the alveoli were nearly effaced; he had worn the next molar tooth down to the roots, and he had even already lost on one side one of the stumps of the root, whilst the stumps on the other side still remained. (*m*, plate 40, fig. 4).

But if this rhinoceros had lost molar teeth with age, he had not gained incisors; that does not happen more to him than to other animals which become old. The two small intermediate incisors of the lower jaw (*n*, *n*, plate 40, fig. 4) exist from youth, as is seen in the head given to the cabinet by M. Adrien Camper, and better still by the extremity of the lower jaw of a very young animal, of which a drawing was made by his father, and published in the Acts of Petersburg for 1777, plate ix, fig. 3, copied (plate 42, fig. 5) and reproduced here, from nature, plate 43, fig. 2; but they always remain concealed under the gum; and that was the reason why Meckel had not seen them in the living animal, whilst they are manifest in the skeleton. M. Thomas, a surgeon of London, who has published some anatomical observations on the one-horned rhinoceros, also found these small teeth in the skeleton of an animal four years old.

But what no one to my knowledge has yet published is this, that the rhinoceros has, during a certain time of its life, two similar incisives in the upper jaw; only there they are outside the large ones, whilst in the lower jaw they are between the large ones. This might be already inferred from the drawing of the intermaxillary bone of the very young rhinoceros, given by the elder Camper (in the *Acta Petrop.* t. i, plate ix, fig. 2), and of which I reproduced the subject more entire, plate 43, fig. 3. At first I even thought that this character necessarily indicated another species; but on examining the drawings of the anatomy of our rhinoceros, made with the greatest care by Marechal, under the eyes of Vicq-d'Azyr and Mertrud, I recognized the figure of a very small tooth outside the upper great incisive of the right side; and I saw in the explanation accompanying this drawing, and which is from the hand of Vicq-d'Azyr, that there was on this side a small tooth, which was wanting on the other side: on recurring to the skeleton, I found there on one side a remnant of an alveolus; but the tooth, already too much rooted up, was lost at the time of maceration; on the other side, the alveolus itself was effaced.

The number of the teeth being thus well ascertained, we may now pass on to their description.

In order clearly to understand the teeth of herbivorous animals, it is not sufficient to see them, as those of carnivorous animals, at a single period of life; these teeth constantly wearing, the crown also changes continually, and the naturalist must follow them, from the time they pierce the gum, till they fall out of the mouth.

However, it is not always necessary for the purpose, to have at one's disposal individuals of all ages. As the front teeth appear soonest, they are also worn soonest; and one may often follow in a single jaw all the degrees of detrition, going from the posterior to the anterior teeth.

Here then is what is observed regarding the teeth of the one-horned rhinoceros of India, and first to the upper teeth, plate 40,

fig. 3\*. The base or neck of the tooth is quadrangular; the internal side, *ec*, and the posterior, *eb*, are a little shorter than the anterior, *ca*, and than the exterior, *ab*; consequently the latter intercept an acute angle, *a*, and the others an obtuse angle, *e*.

On this base (supposing the side of the root below), there are raised eminences, the summit of which is cutting (trenchant) and entirely covered with enamel, so long as the tooth is not worn down.

One of these eminences, *ab*, follows exactly the external edge of the tooth, or rather the form: it has a vertical side, blunt and a little prominent towards the anterior third (in *d*).

The second eminence, *ac*, is towards the anterior edge; it is joined to the first at the external anterior angle; then it is directed towards the internal anterior, but going a little farther back than the anterior edge of the base.

The third eminence, *be*, sets out from the posterior third of the first, goes first directly inwards, then is bifurcated; one of its branches, *f*, forms a root, which goes forward; the other, *e*, goes obliquely backwards towards the posterior internal angle.

Between them there is intercepted a sort of oblique hollow, broader at its lower part, and which opens by a kind of throat at the internal edge of the tooth.

In fine, at the posterior edge of the tooth, which is also that of this third eminence, there is a considerable slope, *g*.

These eminences, at first cutting, and considerably distant from each other at their summits, as they may be seen, for example, plate 43, fig. 1, A and B, have widened bases, which touch. The first effect of detrition is to wear the enamel of the summit, and to uncover everywhere a line of osseous substance edged by two lines of enamel. According as detrition increases, and descends to the thick part of the eminences, the breadth of the osseous part increases, and that of the hollows between the eminences diminishes, as in B, fig. 3, plate 40. When it advances still more, the anterior hook of the third eminence is joined to the second, and from the hollow intercepted by the two eminences, there is separated a round cavity towards the middle of the tooth, as in C, *ib.*; soon after, the other branch of the third eminence is united to the posterior edge of the tooth; and what was but a slope, *g*, becomes a cavity hollowed out on every side: there is then a second cavity behind, as in D and E, *ib.*; then these two transverse eminences are united at their inner extremity, and the depression which they intercepted is changed into a great excavated hollow, of an irregularly oval figure, and placed obliquely before the tooth again, as at D. It is even sometimes divided into two, when it is worn down to the bottom, as at E and F. Finally, when detrition has gone as far as the base of the eminences, even the hollows disappear, and the crown merely presents a surface of osseous substance surrounded by an edge of enamel, as at G.

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\* Figs. 3 and 4 of plate 43 are taken from an old animal. Fig. 1, plate 43, though belonging to the Java species, being from a younger animal, gives an idea of what these teeth are before they are so much used.

The last molar tooth, A, differs from the five which precede it, in its base being triangular, in there being no slope at its posterior edge, and consequently in there being formed no second round or ova fossette.

With respect to the first molar tooth, it appears that it is always smaller, and that its anterior angle is more acute; it is also nearly triangular, but in a different way from the last.

The internal surface of all these molar teeth presents above the neck two conical and projecting portions, which are the extremities of their two eminences; externally they present a broad surface slightly undulated, and marked towards the anterior third or fourth by a vertical side, very little projecting, *d, d, d*.

The differences of forms, which detrition produces, are much less considerable in the inferior molar teeth.

They consist of two eminences formed out into a portion of a cylindrical surface, *a, b*, fig. 5, and placed obliquely the one behind the other; so that their concavity is directed inwards and a little forwards. Detrition only enlarges the crescents of their summits; but this figure of double crescent, *c, d*, fig. 4; and *e, f, g, h*, fig. 2, is preserved, until the eminences are worn to their base, at which period the tooth becomes rectangular and simple, *i, k, l*, fig. 4.

The crescents are so much the more convex, and so much the more obliquely placed, with respect to each other, according as they are observed in a tooth placed more posteriorly.

The anterior molars are placed in a slightly serpentine line.

With respect to the incisors, the upper ones have the peculiar character of being very much compressed and placed obliquely, forming together in this case an angle of ninety degrees. The great inferior teeth are truncated and nearly cylindrical in the individual now before me: but I think it arises from the kind of life it was made to follow at the Menagerie of Versailles, and that naturally they would be in the form of an acute pyramid, as those of the unicorn rhinoceros of Java.

The senile or external upper teeth appear likewise to have been compressed.

The small intermediate teeth below are conical.

Such are the teeth of a very old unicorn rhinoceros of India. I have not had an opportunity of following their succession; but I have no doubt that in this respect what I shall soon have to say of the other species is also applicable to this.

### 3. *The Vertebrae.*

There are 56 in all: 7 cervical, 19 dorsal, 3 lumbar, 5 sacral, 22 coccygian.

The atlas (plate 41, figs. 27, 28, 29, and 30) has its transverse processes very large, and very broad, and without obliquity; so that their contour is almost rectangular, which distinguishes them from the hippopotamus; their very great size still better distinguishes this atlas from that of the elephant. The spinous process is but a large tubercle. There is under the body a small longitudinal ridge.

The transverse processes of the axis are slender, pointed, and in-



clined backwards; the upper ridges large, not lengthened, and trifurcated behind; there is also beneath it a slight projecting ridge, which becomes widened posteriorly.

The transverse processes of the four following vertebræ are very broad, and go on widening as far as the last of the four. Each has at the posterior edge a point which is directed obliquely backwards whilst it ascends.

The seventh has but a small one, which is articulated with that of the sixth, which must very much interfere with their respective movements.

All have below broad ridges or rather tuberosities.

The spinous processes proceed in the form of a crescent; that of the third is but 0,04, that of the seventh 0,25.

Among the dorsal vertebræ the second has its spinous process longest, and amounting to 0,40; it is also very thick. These processes go on diminishing in length, and flattening at the sides as far as the thirteenth, which is the shortest; it amounts to 0,12, and they again increase. That of the first lumbar vertebræ is 0,15. The three spinous processes of the lumbar vertebræ are vertical; all those of the back incline posteriorly. The transverse processes are very short, and present to the tubercles of the ribs facettes which are nearly vertical: those of the loins are a little longer. The two last touch.

All these vertebræ, reckoning from the third cervical, have the anterior surface of their body convex and the posterior concave.

The five spinous processes of the sacrum are soldered into an elevated ridge, but as well as the sacrum itself, they are very short. The first six vertebræ of the cauda have an annular portion, and spinous and transverse processes. The remaining sixteen are simply pyramidal, and go on diminishing in size.

#### 4. *The Ribs.*

There are nineteen pairs, seven of which are true. These ribs are easily recognized by their proportional size, and by the great arch which their curve forms. The first pair are soldered together below. The sternum of this adult consists of four bones. The first is compressed into the form of a vomer (*soc de charrue*), and forms a pointed prominence anterior to the first rib.

#### 5. *The Anterior Extremity.*

The *Scapula* (plate 41, figs. 5 and 6) is oblong; its greatest breadth is at its upper fourth, *a b*: its posterior edge is raised and thickened in this place, *b*. The crest has a very prominent process, *C*, at the upper third, inclining a little backwards; this crest terminates at the lower fourth of the scapula, in *d*. There is consequently no acromion: a tuberosity, *e*, takes the place of the coracoid process; the glenoid cavity, *f g*, is almost round.

This figure of the scapula of the rhinoceros will always distinguish it from those of the other great quadrupeds; that of the elephant, for instance, is an almost equilateral triangle, and the spine has a great recurrent apophysis.

The *Humerus* (ib., figs. 7, 8, 9, and 10) is very remarkable in this, that its great tuberosity, *a b*, is a broad ridge, which is directed from before backwards, and that the linea aspera, which is there triangular instead of being linear, terminates inferiorly in a very prominent hook, *c*. The anterior extremity, *a*, of the great tuberosity, forms a hook anteriorly; the small tuberosity, *d*, forms a similar one; between both there is a broad canal, which is no doubt for the tendon of the biceps. All these characters will very well distinguish the humerus of the rhinoceros from that of every other large quadruped. The external condyle, *e*, does not project much: the other, *f*, does not at all project: the inferior articulation is in the form of a simple pulley, a little oblique, thicker on the inner side, hollow in the middle.

The *Radius* (ib., figs. 14, 15, and 16) occupies, above all, the anterior parts of the fore-arm; its head, *a b*, is formed into a simple projecting pulley of an oblong form, broader at the external edge; it can only flex, not turn; below it widens nearly as much as above, and terminates by two sharp apophyses—an internal pointed one, *c*, and a truncated one, *d*; the latter receives the semilunar bone; between them is a fossa which receives the scaphoid; its greatest narrowing is towards its upper third, *f*.

The *Cubitus* (ib., figs. 11, 12, and 13), almost triangular in every way, has towards the base a cavity, which receives a projection of the radius: it terminates by a cavity for the cuneiform bone; the olecranon is very much compressed, enlarged at the extremity, and constitutes the fourth of the entire bone.

The *Carpus* of the rhinoceros (plate 43, fig. 5), and those of the tapir and horse, are formed on a common model. However, the rhinoceros and tapir resemble each other much more than they resemble the horse, whose bones in particular are more depressed, and have their articulating surfaces flatter.

The *Scaphoid*, *a*, has its upper facette nearly square, obliquely very concave externally and posteriorly convex towards the external anterior angle. A considerable ridge separates the trapezoidian facette from that of the os magnum, which are both in the form of a hollow pulley. The trapezian facette is triangular and very small. The superior external lateral facette for the semilunar bone extends over its entire length. The inferior one, for the same bone, is but at the anterior angle.

The *Semilunar* bone, *b*, has its upper facette irregularly oval and entirely convex, behind which there is a tuberosity inclining backwards and curved towards the lower part. Two elliptical facettes correspond to the upper one of the scaphoid. The lower surface is divided obliquely and irregularly into two concave facettes, one for the posterior part of the upper facette of the os magnum; the other for the internal upper facette of the unciform bone, and behind this there is still a rough portion. The anterior surface is square, and not pointed upwards as in the hippopotamus. On the internal surface there are two facettes for the *cuneiform* bone. The lower one occupies the entire length of the bone.

The *Cuneiform* bone has, as is usual, its upper surface concave and descending obliquely towards the external edge; the lower one is also

concave, and almost round. On the inner side it presents two facettes, both semi-elliptical, for the os semilunare.

The *Pisiform* bone, *d*, is oblong, thicker externally, and a little crooked. Its cuneiform and cubital surfaces form together an angle of sixty degrees, and are almost equal.

The *Trapezoid*, *g*, has its upper and lower facettes concave. The upper is curved externally, so as to present one of them to a *conical osselet*, which rests also on the scaphoid and occupies the place of the trapezium and of all the thumb.

The *Os Magnum*, *f*, has its anterior surface rhomboidal, but the lower edge is in the form of a convex semicircle. The upper is concave, to give lodgement to the internal lower facette of the scaphoid. The internal is sloped, by reason of the two facettes of the inner surface, the upper of which is for the trapezoid, the lower for the external facette of the head of the first metacarpal bone. The external edge is rectilineal, and commences a square facette which corresponds first to the unciform bone, and is then confounded with the schaphoidian facette, so as to form posteriorly a convex facette, which is lodged in the external inferior concavity of the semilunar bone. Posteriorly the os magnum has a thin and very prominent tuberosity.

The *Unciform* bone, *e*, has its inferior edge semicircular; the superior is angular, by reason of the two facettes, both convex, which it gives to the semilunar and cuneiform bones. The semicircular edge is that of a facette, which proceeding from within outwards, is directed over the outer side of the os magnum, over the external facette of the head of the metacarpal bone of the digitus medius, over the principal surface of the metacarpal bone of the digitus annularis, and over the os rotundum, *h*, which replaces all the digitus minimus. This bone, which also rests on the external surface of the head of the metacarpal bone of the digitus annularis, is partly encased by the projecting and curved posterior tuberosity of the cuneiform bone.

The metacarpal bones are depressed from before backwards; the external ones are curved a little outwards towards the lower part. The pulley of their lower head presents its middle ridge only posteriorly.

None of these bones can be confounded with those of animals of the same size. The tapir, as we have said, presents the closest resemblance, but its small size prevents its being confounded.

#### 6. The Posterior Extremity.

The *Pelvis* (plate 43, fig. 6) is extremely broad, and the elephant is the only quadruped that resembles the rhinoceros in that respect; but that of the rhinoceros is distinguished at once by its forked spine, *a*. The angle of the *os ilium*, which touches the sacrum, is besides more raised, and the neck, *g*, is much longer and narrower.

The external edge of this bone, *abc*, is nearly as large as the internal, *def*, whilst in the elephant it is much smaller. The crest of the *pubis* commences from the upper part of the neck of the os ilium, in *g*. The foramina ovalia are more broad than long. The tuberosity of the *ischium*, *h*, is very large above, and in the form of a crotchet.

The *Femur* of the rhinoceros (plate 41, figs. 1, 2, 3, and 4), is perhaps



still more remarkable than its humerus: its upper part is extremely flattened from before backwards; the eminence, *a*, which I call a third trochanter, projects very much, and forms a hook, which ascends to touch a descending hook of the ordinary great trochanter, *b*, so that a foramen ovale remains between these two eminences. The inferior pulley, *c*, is very narrow anteriorly; the internal edge, *d*, is much more prominent there, and ascends higher than the other, *e*. Posteriorly the two condyles, *f g*, are more separated than anteriorly, but they form nearly the same projection.

The *Tibia* (ib., figs. 17, 18, and 19) has its head in the form of an equilateral triangle: only the posterior internal angle forms a hook-like projection; the anterior angle forms a very great tuberosity beneath the patella. The lower part of the tibia is a little flattened from before backward. The fibula is thin, compressed laterally, and enlarged at its two extremities.

The *Tarsus* and upper part of the metatarsus (plate 43, fig. 4) are constructed on the model of the horse; only the pulley of the astragalus, *b*, is broader, less oblique, and less deep: its posterior internal angle is obliquely truncated; the *astragalus* touches the *cuboid*, *c*, by a tolerably broad facette; the *schaphoid*, *d*, and the third cuneiform are less flattened; the second *cuneiform* and the *cuboid* are greater. In all these points the rhinoceros resembles the tapir more than the horse, and it may even be said, that were it not for the size, it could scarcely be distinguished from the first; but it differs from all two by an *os calcis*, which is thicker and shorter. Its anterior or astragalian surface is triangular. There are two broad facettes for the astragalus; that of the internal side is prolonged into a sort of tail all along the inferior edge of this surface, as in the tapir. In the horse the third facette towards the external angle is distinct. The facette which touches the cuboid is very small.

The facettes of the astragalus (ib., *b*) are the counter-part of those of the *os calcis*; the two edges of its pulley are of equal height. The part of the anterior surface which touches the cuboid is narrow.

The cuboid, *c*, has posteriorly a long and thick protuberance, which is not in the horse. At the internal side of the foot, there is a similar one produced by a supernumerary bone attached to the scaphoid, to the internal cuneiform, and to the internal metatarsal bone, and which represents at once the first cuneiform and the thumb in its entire extent. This bone exists also in the tapir and the horse, but in the latter it soon becomes united with the second cuneiform. The scaphoid, *d*, has then three articulating facettes at its lower, or rather metatarsal surface; the third, or internal cuneiform, *e*, is much smaller than the other, *f*.

The external *Metatarsal*, *g*, is articulated only with the cuboid, and touches the middle metatarsal, *h*, by two facettes of the inner edge of its head: the latter is articulated only with the great cuneiform; it has two smaller facettes for the external. This latter, *i*, touches the preceding and the great cuneiform bone by the internal side, and the supernumerary bone by the external; it has only one facette for this bone.

The *Phalanges* are all more broad than long; the second of the

middle toe is in particular extremely short. The latter are fluted like those of the horse's hoof. The middle one is in the form of a crescent, the others in that of a half crescent, the point of which is towards the edge of the foot.

## ARTICLE II.

### *On the Different Living Rhinoceroses, and their Distinctive Characters.*

The difficulty of seeing different *rhinoceroses*, and particularly of seeing them together, for a long time retarded the knowledge of the real characters of their species. These animals have been rare at all times. Aristotle makes no mention of them at all, unless it be his Indian ass, of which he says but one word. The first of which mention is made in history was that which appeared at the celebrated fete of Ptolemy Philadelphus, and which was made to go last of the strange animals, apparently as being the most curious and most rare; it was from Ethiopia (Athéneus, lib. v, p. 201, ed. 1597). The first seen in Europe appeared at the games of Pompey; Pliny says that it had but one horn, and that this was the ordinary number (lib. viii, cap. 20). Augustus had another killed in the Circus, with a hippopotamus, when he triumphed over Cleopatra. Dion Cassius, who relates this fact (lib. li), seems to intimate that it was a unicorn: *Cornu autem ex ipso naso prominens habet*. He adds, according to the authority of Pliny, in the passage just cited, that they were the first of the two species of quadrupeds seen at Rome: *tunc primum et visi Romæ et occisi sunt*.

Strabo (lib. xvi, p. 1120, Almel.) describes very exactly a one-horned rhinoceros, which he saw at Alexandria; he even speaks of the folds of his skin.

Pausanias, on his part, describes in detail the position of the two horns in the two-horned rhinoceros, which he calls the Ethiopian bull, (lib. ix, p. 572 ed. Hanov., 1613).

Two of this latter species appeared at Rome, in the reign of Domitian, which were engraved on some medals of this emperor, and formed the subject of some Epigram of Martial, which the moderns were for a long time very much perplexed to explain, because there was mention made of the two horns. Schrœck explained it, however, since 1688, in the Ephemerides of the Curiosi Naturæ.

Antonine, Heliogabalus, and Gordian III., also showed some rhinoceroses\*.

Cosmas speaks expressly of that of Ethiopia, as having two horns, and being able to move them†.

The antients then had some knowledge of these animals, which was for a long time not possessed by the moderns.

The first seen by the latter was of the one-horned species. It had been sent from India to Emmanuel, King of Portugal, in the year 1513. This king made a present of it to the pope; but the animal having had a fit of madness on the voyage, destroyed the vessel which conveyed it.

\* For Antonine, See Jul. Capitol., Antonin. Pius, cap. x. But some editors put *strepsicerotas* instead of *rhinoceroses*. For Heliogabalus, Lamprid., c. xxviii; for Gordian, Jul. Capit., Gord., c. xxxiii.

† Ap. Montfaucon, Collect. patr. tom. ii, p. 334.

A drawing of it was sent from Lisbon to Albert Durer, the celebrated painter and engraver of Nuremberg; he engraved a figure of it, which the books on natural history for a long time recopied (Gesner, quadr., p. 841; Aldrov. bisulc., 884: Jonst. quadr., t. xxxviii). It is very good for a general outline; but the wrinkles and tubercles of the skin are exaggerated in it, so much so, as to make one suppose that the animal was covered with scales, or rather with the valves of shells.

A second was brought to England in 1685; a third was exhibited almost over all Europe in 1739; and a fourth, which was a female, in 1741. That of 1739 was described, and a drawing made of it by Parsons, (Phil. Trans. xlii. No. 523), who mention also that of 1741. I think the latter was the same as that which was exhibited in Paris, in 1749, painted by Oudry, then designed by Edwards in 1752\*; in a word, this is also the one of which a figure is given by Albinus, in plates 4 and 8 of his history of the muscles. It was described by Daubenton, and observations made on it by Meckel.

That whose osteology we have described, is consequently but the fifth. It came very young to Versailles, in 1771. Buffon speaks of it in his Supplements, tome iii, plate 287, and it died in 1793, at the age of twenty-five or twenty-six years.

A sixth, which was very young, designed for the menagerie of the Emperor of Germany, died in London, a little after its arrival from India, in 1800, and was dissected by M. Thomas, a surgeon, who published his observations on it in the Philosophical Transactions. We saw one in Paris, in 1814, which was carried to Germany†.

These seven animals were all one-horned.

Two individuals described by travellers, to wit, that which Chardin saw at Ispahan, and which came from Ethiopia, and that of which Pison gave a figure in the Natural History of India, from Bontius, had also but one horn.

Thus, on the one hand, the *two-horned rhinoceros*, was never brought alive to Europe in modern times; and on the other hand, travellers were a long time in giving a detailed description of it. It was known only by its horns, which were to be found in several cabinets.

Aldrovande had to be sure published a tolerably just figure of it (Solid. p. 383), which had been communicated to him by Camerarius, a physician of Nuremberg; but this figure, without either description or detail, was very badly copied by Jonston, tab. xi, and totally forgotten by other naturalists.

Parsons‡ was the first who tried to prove that the *one-horned rhinoceros* always belongs to Asia, and the *two-horned* to Africa.

Though Flaccourt§ saw the latter in the bay of Saldanah; though Kolbe, Biebering, and others, always considered the rhinoceros of the Cape is two-horned, Colonel Gordon was the first who gave an accurate and complete description of this species, and his description was inserted, by Allamand, in the Supplements of Buffon||.

\* Edwards, Glean., plate cexxi.

† It was seen again in Paris, in 1833.

‡ Phil. Trans., tome xlii, No. 523.

§ Flaccourt, Hist. de Madagascar, p. 378.

|| Suppl. de l'ed. de Hollande, tome v, p. 9. et plate v; et dans l'ed. de Paris, tome vi, p. 78, et pl. vi.



Sparmann gave another in the *Memoirs of the Academy of Sweden* for 1778, and in the account of his travels, French translation, tom. ii.

It was then known, that besides the number of horns, the *rhinoceros of the Cape* differs from that of India in its skin entirely wanting these extraordinary folds which distinguish the latter; but it was Camper who finally determined these two species, by first shewing in his *Treatise on the two-horned rhinoceros*, that the *rhinoceros of the Cape*, as Sparmann also stated, has but twenty-eight molars without incisors, and then in confirming, by his own observation, what Parsons and Daubenton had said before him, that the Indian rhinoceros has, in front, incisors separated from the molars by an empty space.

But besides these two species, which are well known, there are some which are less so.

William Bell, in the service of the India Company at Bencoulen, described in 1793, in the *Philosophical Transactions*, a *rhinoceros of Sumatra*, which had been already alluded to\* by Charles Miller\*, and which seemed to form a third species, and to hold a sort of middle place between the two others; for it has two horns, and the skin is very little folded, as that of the Cape, and still it has incisors like that of India.

We give, plate 42, fig. 8, the copy of the cranium, drawn by M. Bell: it is that of rather a young animal, for it has only six molars as yet come out.

We also give, plate 42, fig. 2, a cranium of an animal a little older, of the *one-horned rhinoceros of Java*, which resembles very much this *two-horned rhinoceros of Sumatra*; it is the same as that already described by Camper in a separate plate, and which M. Blumenbach had copied (*Abbild. cap. 1, plate vii*); but we disencumbered it of its ligaments and horn, in order to have a new drawing taken of it.

Its last molar tooth just pierced the alveolus, and did not yet begin to be worn.

On comparing it to that of Sumatra, we find that the latter has the posterior angle of the lower jaw more obtuse, and the ascending ramus narrower, which might be owing to the less advanced development of its teeth; that the bones of the nose, which carry the first horn, are less raised, and that the incisive bones are more curved towards the lower part, and have not that small angle projecting forward, which is observable in the *one-horned*.

Neither do we see, in M. Bell's figures, traces of small intermediate incisive teeth below, nor their alveoli, nor does he speak of them in his description; but as this was very much abridged, one might suspect that it was forgotten, and, in fact, the existence of these small teeth has been recently ascertained in Sumatra, by M.M. Duvaucel and Diard.

It was then obvious, from this first examination, that the differences of these two craniums were really less than those which might have been remarked between the cranium of a young *one-horned rhinoceros of Java*, and that of the *Indian one-horned*, an adult, which we represent separately, plate 42, fig. 1, the skeleton of which we have also de-

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\* Apud Pennant, *Hist. of Quadrup.*, 3rd. edit. i, 152.

scribed; that consequently the *one-horned of Java*, and that of *India*, could hardly be considered as belonging to the same species.

I should not have insisted on the detrition of the incisors of the latter, which is accidental, nor on the posterior angle of the lower jaw, which is less obtuse: it is the effect of the development of the seventh molar tooth, and consequently produced by age.

Neither should I have dwelt on the very great rugosities of the bones of the nose, and of the zygomatic arch, which may also arise from age.

But we could not so easily account for the disproportionate elevation of the cranium, and of the occipital ridge. The entire height of the head placed on its lower jaw is, in the *Indian adult*, to the same dimension in the young one of *Java*, as four to three, while their lengths are equal. In particular, it could not be conceived how the process observed at the lower edge of the nostril could be entirely wanting in the young skull of *Java*.

There was observed again in the animal which I had before me, a difference which struck me very much, but which I afterwards ascertained to be merely the result of accident.

We have seen, from Vicq-d'Azyr, that the *one-horned rhinoceros of India*, an adult, had on one side a stump of external incisors outside the great one above. We also saw, from Camper, Mem. de Petersb. for 1777, plate 2, p. 211, that a very young head of a *one-horned rhinoceros*, exhibited in the incisive bone, on either side, two well-marked alveoli; and, in order to shew the matter clearly, we had copied, plate 42, fig. 4, the figure given by Camper of this incisive bone, and fig. 5, that of the extremity of the lower jaw corresponding to it. We even give anew those parts, which we had caused to be designed from nature, at Franeker, plate 43, figs. 2 and 3.

Now this *one-horned rhinoceros of Java*, of intermediate age, (plate 42, fig. 2, and plate 43, fig. 1), has no external incisors, and presents no trace of alveoli which could contain them.

How, said I to myself, could that be, if the skull was of the same species, as this very young and this very old one, each of which exhibited traces of this tooth?

Peter Camper appears to have already recognized this difference between the rhinoceroses of Asia: "I had an opportunity (says he in a letter to Pallas, inserted in the *Neue nordische Beyträge*, vii, 249), to distinguish two species of Asiatic rhinoceroses, which have each four large incisors. I shall send, on this subject, to the Academy of Petersburg, the continuation of my memoir on these animals. The death of this great man, which happened a little after, prevented him from executing his design: but as it is one of the heads in his cabinet, which has served as the base of my preceding observations, it is probable that his had the same source, and led him to the same result.

The conjectures which these characters caused me to form, on the existence, at *Java*, of a second species of *one-horned rhinoceros*, have been fully confirmed by the observations of two of my pupils, MM. Diard and Duvaucel, contained in a memoir which they presented to the Society of Sciences at Batavia, and by an adult skeleton and a skin of this species which they sent to us.

Being of a somewhat smaller size than the rhinoceros of *India*, that of *Java* has all its physiognomy; its hide is equally divided, by large folds, into compartments similar to pieces of cuirass; its teeth are similar, and it is by the details of its osteology, as we shall see hereafter, that it is best distinguished. The female obviously differs from the male by its horn, which is reduced to a semi-ovoid tuberosity. The fœtus has, from the moment of its birth, the same folds in the skin as the adult. This animal goes by the name of *Badak*\*.

The same young naturalists have satisfied themselves that this rhinoceros, peculiar up to the present to the isle of *Java*, is not a mere variety of the *two-horned* one of *Sumatra*. Besides the differences which I already remarked, they have remarked others in their skin, and in their entire structure.

With respect to the *two-horned rhinoceros of the Cape*, there has been for this long time back, no doubt; but that it is a species which will not allow itself to be confounded with any other.

Not only its skin has no folds; not only the general form of its head is different; not only has it uniformly two horns; but it never has more than twenty-eight teeth, all molars; it always wants incisors, and has not even room for them at the anterior extremity of its jaws. Its incisive bone is much too small to contain them, and even at its lower jaw, the molar teeth, far from leaving, as in the other rhinoceroses, a great empty space between them and the incisive edge, are so close, that incisors could hardly hold between them.

All these points result from the description given by Camper, of this species of rhinoceros, and an accurate idea may be formed of it by consulting our plate 40, where the teeth of the *one-horned* and the *two-horned* species are represented, and figures 6 and 7 of our plate 42.

Figure 6 is a copy of that which Camper thrice gave of a skull of an adult *two-horned rhinoceros of the Cape*. Fig. 7, is that of a young skull of the same species, belonging to our museums, which has but five molars come forward. It is found perfectly similar to that given by Sparmann, Voyage, French Trans. tom. ii, plate 3.

We see that these two skulls perceptibly differ from one another only in a little greater proportional length in the adult—a natural result of the development of two additional molars, on each side, in each jaw.

Such are the rhinoceroses discovered up to the present day, living and sufficiently described or observed.

I know that Bruce† published a figure of a *two-horned* rhinoceros very different from that of the *Cape*, and from that of *Sumatra*, which he states he saw in Abyssinia; but this figure is only a copy of that of the *one-horned* given by Buffon, to which Bruce had merely added a horn. Did he determine to draw this figure thus, because he had really seen another which it resembled? or did he only commit a plagiarism which nothing can excuse? I shall readily adopt this latter supposition, since M. Salt‡, a more credible author than Bruce, assures us that the

\* These details are extracted from a manuscript memoir of MM. Diard and Duvaucel. The name *Abada*, given to the rhinoceros by several authors, is a corruption of *Badak*.

† Voyage to the Sources of the Nile, p. 25.

‡ Travels in Abyssinia, App., No. ii, French trans. ii, p. 331.



rhinoceros of Abyssinia is *two-horned*, and resembles that of the *Cape*, the figure of which has been given by M. Barrow. But supposing even that Bruce really saw the animal which he represents, it might be probably but an individual accidentally *two-horned* of the *Indian* species, or with incisive teeth. It would deviate still less from this species than the rhinoceros of Sumatra, which is also *two-horned*.

In fine, M. Burchel (Journ. de Phys., Aug. 1817), assures us that he saw in Africa a *two-horned* rhinoceros, which was much larger than the ordinary one, the upper lip of which did not terminate in a moveable point, but was short and truncated: which induced him to give this animal the name of *rhinoceros simus*. From the tables of the measures which this traveller joins to his description, this *rhinoceros simus* might also have the head much larger in proportion to the body, than the common *two-horned*, the bodies of these two species being as 11 to 13, and the heads as 13 to 21. It is much to be desired, that naturalists should obtain a more complete description of this rhinoceros and particularly a good figure of its skull.

If this species, which has more probability than that of Bruce, comes to be confirmed, it will raise the number of living rhinoceroses to five.

#### *Additions to this Article.*

From the communications sent by MM. Diard and Duvaucel, and the capture made at the Cape by M. Delalande, the King's Cabinet has the advantage of possessing at present, and of presenting to naturalists, the four species of rhinoceroses—that of India, Java, Sumatra, and the Cape, perfectly prepared, all placed opposite each other. They present external characters, independent of those which we have pointed out from their skeleton, a resumé of which will not be unacceptable here.

The one-horned rhinoceros of Java has the skin all covered with small angular hard scales, resembling those of the shields which cover the shoulders of the tatoos. It has a transverse fold behind the shoulders, another before the thighs, a longitudinal fold on the upper part of each thigh; the skin of its neck is very much plaited, and there arises from it a fold, which, uniting with its corresponding one, intercepts on the back part of the neck, a sort of semi-elliptical patch.

The one-horned rhinoceros of the continent of Asia has the skin unequal, but not covered with small angular scales. Its folds are the same as those on the preceding, except that the fold which arises from the skin of the neck, traverses the upper part of the shoulder obliquely, and terminates behind, without uniting it to the corresponding one, nor forming on the back of the neck, that semi-elliptical portion which distinguishes the rhinoceroses of Java.

The two-horned rhinoceros of Sumatra has the skin, in some places, as it were, scabby, but every where covered with hairs, which are thin set, black, rigid, nearly an inch long; they are thick enough on the legs. The folds of the neck are not so thick, those behind the shoulders and before the thighs less deep, and there is no transverse fold either on the shoulder or on the croup.

It is very probable, according to M. Diard, that it is this latter animal which has been given for a hippopotamus.

Our great rhinoceros of the continent is 10 feet long by  $4\frac{1}{2}$  feet high;

that of Sumatra is 6 feet 8 inches long, and 4 feet high. We have, as yet, from Java, but one young individual, 5 feet 6 inches long and 3 feet high; but we see by the skeleton, that the species becomes greater than that of Sumatra.

*Another Addition.*

M. Campbell, (sent from the London Missionary Society), in the account of his second voyage to the south of Africa\*, states that several rhinoceroses had entered the city of Mashaw, the chief place of a plantation in the interior, situate nearly under the tropic of Capricorn; the inhabitants killed four of them, of which they gave him a head which he deposited in the Museum of the Society to which he belongs, in the Old Jewry, London.

The first view of this head is very striking, by reason of its anterior horn being much longer, thinner, and being directed more forwards, than in the ordinary rhinoceroses of Africa—resembling, however, several of those seen in the cabinets.

Sir Everard Home published, in the Philosophical Transactions of 1822, 1st part, p. 38, a figure of this head, very well drawn by M. Clift, and considered it as presenting a *perfect resemblance to the fossil skulls of Siberia. This resemblance is such, added he, that there no longer remains any marked character, and that if the one was not fossil, and the other living, they would be referred to the same species.* To render this resemblance more sensible to his readers, he caused to be engraved, at the same time, the figure of a skull of a fossil rhinoceros, 33 English inches long, formerly given to Sir J. Banks by the Emperor of Russia, and now deposited in the British Museum, which, according to the author's own words, is similar to that which M. Buckland was kind enough to present to the King's Cabinet. Sir Everard Home considers these observations as *calculated to diminish considerably our faith in the differences of living animals and fossil animals.*

So novel a result, announced by so distinguished an anatomist, could not fail to attract all my attention.

Indeed, it was already easy for me, even from Sir Everard's figure alone, to see that this resemblance was far from being complete.

Any one may satisfy himself, as I did, by merely throwing his eye over these figures, which I had sketched, plate 201, figs. 2 and 3, and above which I caused to be placed, fig. 1, that of an ordinary rhinoceros of Africa, with two horns, disencumbered, as were the two others, of its lower jaw.

Abstracting from the occiput and zygomatic arch of the head of the Caffreian rhinoceros, fig. 2, it is manifest to any one that this head has the same profile, the same proportions between the height and length, between the anterior part as far as the orbit, and the posterior part behind the orbit, the same form of nasal slope, the same position of the horns and teeth, as the ordinary head of that of Africa, fig. 1, and that it is only a little larger, but only so in a degree not exceeding that which

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\* Travels in South Africa, &c., by the Rev. John Campbell, 2 vols. Lond., 1822, v. i, p. 294.



is every day seen between individuals of the same species; on the contrary, it is at once seen that this Cafrerian head differs considerably in all these particulars, from the fossil head, fig. 3.

This latter is much more elongated in proportion to its height; its nasal slope is much deeper, the nasal branch of the maxillary bone is longer and narrower; it presents in one word, in this simple drawing, all the characters of general form which I pointed out so many times, and by which it is just as easy to distinguish it from the head of the Cafrerian animal, as from the other heads of living rhinoceroses observed up to the present day.

But there was still a more simple, and, if possible, a more decisive means, to satisfy one's self whether this rhinoceros of Cafreria, resembles the fossil one in an essential character: it was to see whether its septum narium was ossified. Astonished that Sir Everard, in all his paper, had entirely omitted to speak on this point, which was one of the most importance, I entreated a learned naturalist, a friend of mine, who was in London, to have the kindness to ascertain it. The following are his exact words in answer to me:—

“I repaired yesterday to the Museum of the Missionary Society, (Old Jewry, Cheapside), and examined the septum narium of the African rhinoceros represented in the Philosophical Transactions of 1822, placing the head between me and the light, and I found that it was semi-transparent, and consisted of cartilage, or of ligamento-cartilaginous substance, without any appearance of ossification in any part of it; thus, notwithstanding the great resemblance which exists as to general form between this skull and the fossil skulls, *it differs, with respect to the septum narium, from all the fossil skulls which I have ever seen, all of which have this septum ossified.*”

Any one can go to the Museum of the Missionary Society to verify this fact, and thus satisfy himself by his own eyes, that the *rhinoceros of Mashaw*, were it a new species, is no less a species as essentially different from the fossil rhinoceros with partitioned nares, than the other living species.

But I do not even think that it is a particular species. The length and direction of the horns may vary, and in fact do vary considerably in different individuals in the rhinoceros of the Cape; and with respect to the superiority of size, we can affirm that it scarcely exceeds, that it does not even approach that which takes place between equally adult individuals in the two-horned species of Sumatra.

#### ARTICLE III.

*Osteological comparison of the two-horned Rhinoceros of the Cape, and of the one-horned Rhinoceros of Java, with the one-horned of India.*

Just at the moment I was arranging this chapter, I was so fortunate as to receive from the Cape a complete skeleton of an adult two-horned rhinoceros, prepared by the indefatigable M. Delalande; and a very few days after, I received from Java that of the one-horned rhinoceros of that island, obtained in the woods by M. Diard, a naturalist as estimable for his great knowledge, as for the courageous devotion which car-



ries him into climates so distant and so dangerous, solely for the advancement of science. These two valuable acquisitions afford the most solid support to all this history of fossile rhinoceroses.

### I. *Of the two-horned Rhinoceros of the Cape.*

Its skeleton is represented plate 54; its head, plate 42, figs. 6 and 7.

We have seen the principal differences of the head. A minute examination still discovers some.

#### I. On the upper aspect.

1st. The horizontal contour of the bones of the nose is rounded in the two-horned rhinoceros, pointed in the one-horned. A deep furrow marks their suture anteriorly in the first.

2nd. The space between the post-orbital processes is bunched out in the two-horned animal, transversely concave in the one-horned.

3rd. From this part to the occipital ridge, the cranium of the two-horned rhinoceros appears much longer, because this ridge is directed obliquely backwards, whilst it is vertical in the one-horned animal.

4th. The temporal fossæ approach less closely in the two-horned, which leaves the upper and truncated part of the occipital ridge broader.

5th. The zygomatic arches are less asunder posteriorly, whilst in the one-horned they form a salient angle; a circumstance which, joined to the difference in the bones of the nose, causes the horizontal general contour of the one-horned to be triangular, and that of the two-horned to be oblong.

#### II. In the profile, the principal differences are owing :

1st. To the form of the incisive bones, which in the one-horned advance as far as the bones of the nose, and have above a peculiar process; in the two-horned, they are reduced each to a small oblong piece.

2nd. To the convexity of the suborbital space of the two-horned, already mentioned.

3rd. To the elevation of the occipital ridge of the one-horned, and to its flat position in the two-horned; whence it happens that at an equal distance between the occipital condyles and the muzzle, the one-horned has the upper part of the cranium much shorter than the two-horned.

III. At the lower aspect, besides the differences which arise from the form of the arches, and the direction of the occipital ridge, and that which is produced in front of the palate by the difference of the incisive bones, we observe :—

1st. That the row of molar teeth is longer in the two-horned, and that it converges anteriorly with that of the other side : in the one-horned they are parallel.

2nd. That the palatine fissure is pointed anteriorly in the two-horned, rounded in the one-horned : in both it advances as far as the penultimate molar tooth.

3rd. That the basilar region is longer in the two-horned, so that we find posteriorly, what had been lost anteriorly with respect to the length.

IV. The posterior aspect, semi-elliptical and more high than broad



in the one-horned, is quadrangular, and is a little more broad than high in the two-horned.

The occipital foramen is also more broad than high, whilst in the one-horned it has the contrary proportions.

The principal differences of the lower jaws are, besides the length of the part preceding the molars, which is much less in the two-horned than in the one-horned—1st. that the rows of molars is longer in the two-horned; 2nd. that the ascending rami are much less high; 3rd. that the coronoid processes are much less long, less acute, and less directed forwards; 4th. that the dental branches are much more protuberant externally.

The upper molars of the adult two-horned rhinoceros (plate 56, fig. 1), taken separately, are greater than those of the two one-horned, and may be distinguished from them, because their posterior edge being less raised, the fissure of this edge is not changed into a fossette, as in the two one-horned species, but remains a real fissure, at least till the tooth is worn to the height of the neck. Besides, the hook of the posterior eminence remains distinct from the anterior eminence later than in the one-horned, so that there is not observed, at least in the animals which I have seen, any of those hollows which are preserved at a certain age in the upper molars of the one-horned.

However, this remark does not apply to the milk teeth of the two-horned, which I observed in our young head of the Cape, and which are seen, plate 40, fig. 1, B, C, D, and E. We there distinctly see the fossette detached from the anterior hollow, and at the second, D, we perceive that the posterior fissure commences to become hollowed.

These four teeth have also this character—of being all of them more long than broad. They afford us the indication that in the other rhinoceroses, whose milk teeth we have not seen, the proportions will probably be the same, as well as the greatest complication, which, as we have already said, is a sufficiently general rule for herbivorous animals, and perhaps for all animals.

We give, plate 56, fig. 3, a germ of a fifth molar tooth, that is, of a first back tooth, extracted from this young head of a two-horned, and the same as that marked A, plate 40, fig. 1, to the end, that we may be able to see the eminences and their hooks in their perfect state. It is precisely this germ which becomes the tooth C of fig. 1, plate 56.

The *Scapula* of the two-horned is broader above, because its superior angle is more forward, and the posterior is not truncated obliquely. The salient angle of the spine is placed in it a little lower than in the one-horned, and this angle is more obtuse.

The *Humerus* has not the deltoid ridge so long nor so prominent below, nor the posterior angle of the great tuberosity so raised, nor the anterior angle curved before the canal of the biceps, nor the lower head, and particularly its pulley, so broad transversely, nor so oblique. On the whole, however, this bone is not thinner than in the one-horned. Its most obvious difference is the want of a pulley on the part of the external tuberosity before the canal of the biceps.

I find the *olecranon* perceptibly shorter in proportion in the two-horned; the *ulna* thinner, and the radius a little less broad above as well as below. The proportion of this part is also a little different